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ARTICLES

COBALT DEFICIENCY IN FARM ANIMALS

J. B. E. PATTERSON

Soil Chemist, South-Western Province

In the past ten to fifteen years rapid advances have been made in our knowledge of the part played by very small amounts of certain elements in the healthy growth of plants and animals. The effects produced by a deficiency of these elements are specific and, once recognized, can be used for diagnosis and the employment of the proper cure of ill-effects.

Animals are now known to need elements such as copper, iodine, iron, manganese and cobalt, though all these elements are not necessary for all species. Thus absence of manganese is known to produce perosis or "slipped tendon" in chickens, but the requirements of larger animals are small and apparently satisfied by the amounts present in normal mixed diets. Although often discussed, there is no evidence that a lack of manganese is responsible for any of the forms of sterility or infertility of the larger farm animals.

An effect of mineral deficiency which is fairly widespread is seen in the symptoms caused by lack of cobalt in pastures on soils derived from some types of granite, pumice, beach calcareous sands, and rocks of the Old Red Sandstone or Devonian age. It occurs in New Zealand, South Australia, New Hampshire, Florida, and many other countries. In Britain it is known amongst stock in Scotland (Kirkcudbrightshire, Ross-shire, and Caithness) and in England (Devonshire, Cornwall, and the border country in the North). There are other areas where work in progress shows that there is a strong likelihood of its occurrence.

Only ruminants are affected, sheep being more susceptible than cattle. The symptoms comprise a progressive wasting away and emaciation, and are particularly evident in lambs from the beginning of weaning and for the following two or three months. The old name of "pining" is descriptive of the miserable appearance of animals which may die if not moved to healthy pastures or given treatment. In cattle the symptoms are not so clearly marked as in sheep. The coat is rough and staring, and in dark-coloured breeds often turns rusty. Scouring is not a general symptom. In the past it was often held that infestation by worms was the cause of the trouble, but treatment for worms was frequently ineffective, and parasites were not always found on post-mortem inspection.

The condition is by no means new. It was described by Robert Fraser in his *General View of the County of Devon*, written for the newly-formed Board of Agriculture in 1794, and by James Hogg,

the Ettrick Shepherd, in his *Shepherd's Guide* in 1807 and in subsequent writings in the *Quarterly Journal of Agriculture*.

It was noticed by all who encountered the condition that it occurred only on certain soils, and until just over ten years ago the only treatment was wintering away of stock on healthy land, although in 1794 soil from a healthy area was administered with water as a curative drench. This treatment was rediscovered by Rigg and Askew in New Zealand in the classical work carried out in 1934-46.

Aston, Marston and Lines in Australia, and Rigg and Askew in New Zealand, were all prominent in solving the problem. From the similarity of "pining" to anaemia it was expected that iron compounds would be effective both in prevention and cure, and crude iron oxide licks or ferrous ammonium citrate drenches were used with apparent success, until it was noticed that certain batches were ineffective. Chemical and spectrographic analysis of good and bad specimens of licks and of healthy and unhealthy soils soon showed that cobalt was present, though in small traces, in satisfactory licks and healthy soils and almost absent from the other samples. From this point simple and effective methods of prevention and cure were soon devised.

The daily requirements of animals are extremely small—0.1 mg. element per day for a sheep and 0.5 mg. for cattle. In practice ten times this quantity is given in oral treatment.

Three chief methods can be used, depending on circumstances and the farmer's convenience.

1. *Drench.* This is the cheapest in material—less than $\frac{1}{2}$ d. per head per year for sheep and about $\frac{3}{4}$ d. for cattle. It is, of course, troublesome and expensive in labour and is suitable chiefly for experimental work in an area where cobalt deficiency has not previously been proved to exist, or in curative treatment of individual animals.
2. *Licks and Mineral Mixtures.* This is an effective method favoured by many farmers. On some farms the animals have to be "educated" to take the mixture.
3. *Pasture Dressing.* A simple and cheap way of ensuring that all animals obtain their requirements. In this country 2 lb. cobalt sulphate per acre (costing 6s. to 8s.) will last for 4-5 years on grassland, and can thus be given in the first year of a ley. It should be applied in March or April, and can be mixed for ease of distribution with superphosphate, sulphate of ammonia, or sand, but not with lime, slag, or materials containing lime.

It is not essential that a whole farm should be treated; two or three fields can be used as "hospital fields," or on moorland farms half-acre patches on the moor can be treated.

Cobalt is not a "cure-all," and though its salts are fairly cheap, supplies are limited. Diagnosis in an area in which deficiency has not previously been found and proved to occur should be backed by soil and (sometimes) pasture analysis. The latter is not always satisfactory, because the quantity of cobalt in the dry matter of herbage is extremely small—0.08 parts per million and above in healthy areas, while a

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figure of 0.05 p.p.m. and below indicates likelihood of trouble in stock. Very careful sampling is essential to avoid contamination by soil. A further point is that some species of pasture plants, e.g., clover and ryegrass, take up more cobalt than others, such as cocksfoot, and the relative proportions of the species in a field may have an important effect. The stage of plant growth also influences the cobalt content of the dry matter, which is lowest in the summer.

There is a danger that cobalt deficiency may become a "fashionable" disease, and we must avoid confusing the true condition with other stock troubles.

The Soil Survey in New Zealand was begun in an endeavour to solve what was known there as "bush sickness". In North Devon a member of the staff of the Soil Survey of England and Wales has been studying for the past two years the types of soil found in a geologically complex area and their connection with cobalt deficiency.

At present the mechanism of the action of cobalt in animals is not understood, but, as ruminants only are subject to the deficiency, it is to be expected that the study of rumen digestion, begun at Cambridge under Sir Joseph Barcroft, and now being continued at the Rowett Institute, Aberdeen, will throw more light on it. A paper recently published on the subject in *Nature* by Dr. Tosic of the Rowett Institute and Dr. Mitchell of the Macaulay Institute for Soil Research at Aberdeen, makes suggestions based upon experimental evidence.

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Professor H. G. SANDERS

On the face of it there would appear to be a good case for farmers' experiments. There is usually more than one way of doing a job, and what could be more natural than to try out alternatives side by side, noting the result for future guidance? But a result has no use whatsoever unless it can be repeated, and it is just there that the rub comes.

In the last two decades many experiments have been made on cultivations and a number of them have given clear-cut results, but when the same operations have been compared in the succeeding year the difference has failed to appear or has even been reversed; clearly, cultivations may have important effects on yields, but these effects vary with soil and season. It is salutary to do the same cultivation experiment for five or six years running; a common experience is that conclusions swing one way and then the other, with a danger of ending up in the opinion that the cultivations have had no effect at all. The fact is, of course, that what is good and proper in one year and on one soil may be all wrong on a different field in another season; to pick the right cultivation is part of the art of farming, and it will remain an art until much highly scientific work has isolated the factors which are of fundamental importance.

Manurial Trials

An experiment is not much good unless it is carried right through and figures for yields are obtained. Manurial trials are probably the easiest of all to arrange, though results must depend on the natural fertility of the field and on its past treatment. There is something to be said for a farmer carrying out rough manurial trials, such as taking the distributor once across a field ; some farmers tell their men to do this without marking the position, and later on in the growing season they judge the result by whether or not they can find the strip. When this is done a number of times, over several seasons, the farmer must acquire useful knowledge as to what his soil requires.

But manurial trials can be misleading. In some cases manures have early effects which are plain to see, but by harvesting time the differences may have disappeared and fail to show up in yield. The time for applying nitrogenous manure to winter wheat provides a good example of this. As a result of years of experience, that is, in effect, of farmers' rough and ready trials, the practice was well established twenty years ago of applying a top-dressing in February or early March, and it is easy to see how this came about. February nitrogen has spectacular effects ; the soil usually begins to warm up shortly after this time and the nitrogen hastens the re-awakening growth and imparts that rich deep green colour to the foliage which seems to betoken a healthy and vigorous plant.

A large number of careful experiments have, however, shown that dressing earlier (if the winter proves a dry one) or later (after a wet winter) produces greater yield increases than February application. Apart from painting the leaf a dark green, February nitrogen produces a great abundance of late tillers, very few of which succeed in bearing ears. February dressing, therefore, produces more straw and a much greater danger of lodging, but it does not increase the yield so much as a dressing in late April, which will not tend to throw the crop down. There are few worse times to apply nitrogen to wheat than February and yet it is quite understandable how observation, not backed by comparative yields, should have indicated February as the optimum month.

But yield by itself may not be enough. In the case of mangolds, a long series of experiments before this last war showed that Kirsche's Ideal was the variety that produced the highest yield of food per acre ; its strong point was high dry matter content (over 15 per cent, as compared with 13 per cent for other Intermediates), so that it had the double advantage of high yield in low total weight. Unfortunately high dry matter percentage cannot be seen, and the percentage cannot very well be determined on the ordinary farm, so that the real value of the variety was obscured by its obvious smallness of root.

Grassland presents very grave difficulties to the experimenter, and no one has yet found a satisfactory way of measuring the yield of a plot. It is easy enough, by manurial or other treatments, to produce differences in appearance, and experts will venture an opinion as to the relative merits of different swards ; unfortunately the grazing

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animal does not always agree with the experts, though whether or not an animal does really know what is good for itself is open to question.

Wheel Tracks and Roller Consolidation

One other general consideration arises, and that is the difficulty of interpreting a result and of applying it subsequently. On light land it is fairly common to see lines of stronger growth running across a corn crop, and investigation shows that these lines are the tracks of tractor wheels, often of the tractor that pulled the drill. From this it is natural to argue that consolidation of light land is important, as it undoubtedly can be, and thence that rolling should be carried out. The traditional method of consolidating in some light land districts is to follow the plough immediately with a roll, pushing the newly turned furrow down before its surface crumbles.

In one experiment the efficacy of this rolling (with a heavy roll) was being tested and the plots were tractor-drilled at an angle to the ploughing ; this was a case where the tractor wheels showed to advantage (at harvest the yield on their marks was just 50 per cent higher than on the ground between them), and the important point is that the advantage was just as great on the rolled as on the unrolled plots. It must have been true that the field required consolidating, but what it needed was the really squashing action of the tractor wheel ; a roll, even a heavy one, bouncing over the top, did not simulate this and did, in fact, no good at all.

To mention a very different type of experiment : a farmer would have no difficulty in conducting a trial with the new weedicides, but one isolated test is of little use ; a whole series must be carried out before safe conclusions can be drawn as to the right dosage, best conditions for a weedicide and precautions that should be taken.

Rules of Experimentation

To agree with the fairly obvious remarks made above is not to say that it is no use conducting a formal experiment, aimed to give definite measurement of comparative yields. It will be urged later that a farmer can do better than lay down isolated experiments of his own, but there are a few who are keen enough to carry out formal experiments by themselves and to go to the trouble of harvesting a number of plots separately and accurately ; a farmer who possesses a pusher type of combine can, indeed, obtain grain weights from plots with little extra trouble. A brief discussion of the rules of experimentation may therefore be helpful.

If an apparently level crop is harvested in separate small plots it is found in reality to be far from uniform. Away back before the First World War, Mercer and Hall at Rothamsted harvested an acre of wheat and one of mangolds in this way. Each field had been treated alike all over and as far as could be seen carried a nice level crop. They divided their acre of wheat into little areas of $1/500$ th acre each, harvesting these little plots separately, and similarly they harvested the mangold acre in little plots of $1/200$ th acre. The yields they got were far from constant. On the wheat, grain yield per $1/500$ th acre varied from 2.73 lb. to 5.16 lb., and in the mangolds, weight of roots per $1/500$ th acre from

267 lb. to 384 lb. These and many other findings, combined with our general knowledge of soils, make it safe to assume that any field on which it is proposed to experiment is very variable ; there will probably be broad trends in fertility running irregularly from one end to the other, but superimposed on this there will be little patches of all shapes—some good, some bad—scattered higgledy-piggledy all over the field. The irregularities, as expressed in yield, will not be constant from year to year, and they cannot be delineated before the experiment is laid down. It is this heterogeneity of the soil that causes all the trouble, and the modern methods of experimentation have been designed to overcome it. Those methods are based on three principles—replication, randomization, and local control.

Replication means that one plot for each treatment is not enough—each treatment must be applied to at least two (usually more) separate plots. This is common sense, since it reduces the chance of one treatment getting an unfair advantage through happening to fall on a good plot. Replication does something else as well—it allows an estimate to be made of experimental error. Suppose that there is no treatment effect, that the treatments are pure dummies with no influence on yield at all ; no one in his senses would expect the final yields for the different treatments to be identical. There will be some difference, and the question is whether the difference really means something or whether it is due to chance ; this is where replication comes in, because obviously the differences between the replicates of any one treatment are due entirely to chance and from them a measure of the chance variation, or error, can be obtained. Thus it is possible to judge the significance of differences between plots treated differently by comparing them with the differences between plots treated alike. That is a very hackneyed sentence and one that comes as a shock to the beginner, but it is really quite simple if taken slowly and calmly.

The second principle—randomization—has caused much argument and some ribaldry in the past. The decision as to which treatments should go on to which particular plots must be left to chance, there must be no systematic arrangement. Coins may be spun, cards drawn, dice thrown, or any other method used as long as no bias is introduced and the treatments really are allotted at random to the plots. Remembering that there are irregular and unknown variations of soil over the experimental area, it is not unreasonable to leave this allocation to chance ; but the real argument for this principle lies in the working out of the results, a matter outside the scope of this article. Very briefly, when the experiment is finished it will be possible to say, not that one treatment was *certainly* better than another, but that there is a high probability that this is true ; if the odds are some thousands to one the appropriate conclusion can safely be drawn, but it is still a matter of chance and the calculated odds will be wrong unless chance plays its part in the allocation of treatments.

The last principle, local control, seems to some people to be a negation of the one just discussed. Since there are usually broad trends in fertility across a field, a group of plots near together will not

C	E	A	B	D	A	D	C	B	E	B	C	A	E	D	D	B	E	C	A
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

differ so much among themselves as plots a long way apart. If there are, say, five treatments to be replicated four times on twenty plots, the latter can be divided into four groups or blocks of five adjacent plots each, and the rule made that each treatment must occur once, and, of course, once only, in each block. This is clearly a fair procedure for the treatments, but it may appear to conflict with the rule that the treatments be allocated at random ; in reality it does not, because there are still many possible arrangements of the treatments within this restriction, and by drawing cards or by adopting any other method of selection one of the possibilities is chosen at random and the demands of chance distribution met.

It is interesting to observe that the above three principles were incorporated into farming practice more than two thousand years ago. In the Open Field system of farming each man had a plurality of strips in each field (replication), the strips in each year were assigned by lot (randomization), and where fields had big variations in fertility each man had to have strips at the good and at the bad ends (local control). Pure common sense led those early farmers to the three rules to ensure that every man was fairly treated, and the modern experimenter can scarcely do less to get an honest comparison of his treatments.

Application of Principles

The simplest application of the principles is found in the straightforward Randomized Block experiment. Keeping to the example of five treatments (A to E) replicated four times, the treatments are randomized separately in each block and the arrangement might be as at the top of the page. This is a very convenient lay-out for cultivation experiments, variety trials and others.

There are many other possible arrangement of the blocks ; for instance, the shape of the available ground might make the following more convenient :

B	A	E	D	C	E	C	D	A	B
C	A	D	B	E	D	B	A	C	E

It will be realized that each block is a self-contained unit, and therefore the blocks need not necessarily be contiguous. Indeed the present tendency is to widen an experiment, putting down one or more blocks at each of a number of centres scattered, perhaps, over several counties. This has important advantages. There can be many replications, and the treatments are compared under a variety of conditions as regards soil, weather, and so on ; in the final calculation, results can be grouped in any required way to compare the treatments, say, on heavy soil and on light, in the north and in the south. The size of plot and general procedure must be standardized over all the blocks,

so there must be somebody co-ordinating the whole thing, though the actual plot work may be carried out by a number of different people.

Many more complicated lay-outs are possible, still conforming to the three principles, but only one more will be mentioned here—the Latin Square. In this there must be as many replications as treatments and the plots are arranged in a square, each treatment occurring once in every row and once in every column. Thus five treatments require twenty-five plots and could be arranged as illustrated on the right.

D	C	A	E	B
E	A	C	B	D
B	D	E	C	A
A	E	B	D	C
C	B	D	A	E

Even with this double restriction there are many possible arrangements, one of which is selected at random. The Latin Square is in some ways a better arrangement than Randomized Blocks because fertility trends are equalized to treatments in two directions; it is very suitable for manurial experiments (except for combine drilling), but is inconvenient for many forms of inquiry.

Animal Experimentation more Difficult

The co-operation of the farmer and the advisory officer in experimental work is bound to prove fruitful (indeed it has in many instances hitherto) and it may be possible to tackle with success a subject from which many have shied in the past—animal experimentation. There are enough troubles with crop experiments, but at least it is possible to grow a very large number of plants so that genetic variability need not be one trouble; with animals, numbers cannot be anything like so high and consequently this other factor has to be considered. Nevertheless the same principles apply. One animal may be treated as a plot and blocks built up of animals similar in sex, age, weight, breed or milk yield; in a few cases it is even possible to use the Latin Square design in animal experimentation.

Few farmers can find sufficient cattle for a satisfactory experiment; even in a good-sized herd it is difficult to find enough cows alike in age, level of yield, and stage of lactation to make a good block of six. But if a co-operative experiment can be arranged and each farmer contributes one block to it, trustworthy results may be expected without anyone's herd suffering serious disruption.

In British farming, livestock are becoming ever more important, and yet there are probably ten experiments on crops being carried out at the present time for every one on animals; this position could be rectified if experiments of the practical type with animals were arranged co-operatively—it is a line that has been developed with much success in Denmark and a great deal could be got from it in this country.

Whether it is with crops or with livestock, the farmer who is anxious to do experimental work will get more from his efforts if he co-operates with others, through the N.A.A.S., than if he ploughs a lonely furrow.

[Reprinted from *Farming* (Sept.-Oct., 1947) by courtesy of the Editor.]

ABSTRACTS

ANIMAL BREEDING

Identical Twin Genetics in Cattle. Bonnier, G., Hansson, A. and Skjervold, H. Animal Breeding Institute, Wiad, Eldtomta, Sweden. *Acta. Agric. Suecana*, 3.

Since the publication of the second issue of this REVIEW the results of further work on this subject have been made available and are of special interest.

Identical twin heifers, which were fed 33 per cent above "normal" ('A' animals) and 33 per cent below "normal" ('a' animals) prior to calving but fed according to weight and production after calving, have now completed their third lactation. On an average the 'A' animal produced more milk and fat during the first lactation than their 'a' sisters.

The second lactation showed the same results, but the difference in production between 'A' and 'a' animals was smaller. During the third lactation the 'A' and 'a' animals produced equal amounts of milk.

The explanation given for this is that the heifer fed at a low intensity level prior to first calving has, at the time of calving, a certain amount of growing capacity unused. When enough feed is given after calving, a growth-rate is attained which enables the cow to overcome a certain part of her retardation in growth, but at the same time her milk yield does not reach its ceiling. This growth is brought nearer to the sister's level during the second lactation, but it is not finally made good until the third lactation is reached, at which time the lower fed 'a' animal can reach her ceiling for lactation.

It seems probable that the amount of feed which goes to growth or lactation is determined genetically.

The findings at Wiad do not support the belief that if a cow with a high yielding ability is badly fed she will produce less than a cow with lower yielding ability on similar feeding.

The Relation between Average Daily Gain and Some Carcass Measurements. Blunn, C. T. and Baker, M. L. (Nebraska Agric. Exp. Sta., Lincoln). *J. Anim. Sci.*, 6, 424-31.

A study was made to estimate how rate of gain, depth of back fat, length of hind leg and circumference of ham were inherited in pigs. The period of the examination was divided into two, so that the gain made during the main growing period (56-112 days) could be separated from that made during the fattening period (112 days to slaughter).

Environmental factors during the suckling period accounted for 25 per cent of the back fat variation, but the importance of this period on ham circumference was very small. These differences are due, in the main, to the influence of the sow on her litter. Environment after weaning was responsible for between 59 per cent of the variance for length of leg to 80 per cent for circumference of ham.

Simple correlations between gain and depth of back fat and gain and ham circumference were low and positive, while that between gain and length of hind leg was negative. It was found that the dam's influence on the rate of gain was high in the early stages and tended to be less important as the pigs grew older.

Rate of growth due to inheritance during the first period was estimated to be 18 per cent, and this fell to 14 per cent during the fattening period.

Hereditary factors accounted for 12 per cent of the variance for depth of back fat and 23 per cent for length of hind leg. There was a small positive correlation between gain and depth of back fat and gain and ham circumference, but no correlation between gain and length of hind leg. Genetic correlations were positive between gain and ham circumference, but were negative between gain and depth of back fat and gain and length of hind leg.

A significant difference was found between sires for length of leg but not for any other characteristics.

There is an indication that breed may make a difference in the relation between fatness and rate of gain.

Rearing Dairy Heifers. McMeekan, C. P. *N.Z. J. Agric.* 77 (1948), 2.

Rotational grazing experiments with young dairy heifers have been carried out at the Ruakura Research Station, New Zealand, over the past eight years. Calves reared under this system were from 70 lb. to 100 lb. heavier at the end of their first summer than similar calves reared under the common method of set-stocking. The essential for the development of well-grown weaners under the rotational grazing system is that they should be moved around the same pastures as are used by the milking herd, before the pasture is grazed by the herd. Moving should take place frequently, preferably every day or two days, and should start at any early age.

The calves are much healthier, and drenching against worms is unnecessary, whilst the calves under the ordinary method of rearing are subject to a high mortality rate, even when frequently dosed against worms.

Difference in live weight can be accounted for by the fact that calves are very selective grazers and fussy about their food ; if they are not given choice of grass they like, they will not eat sufficient, even though there is ample feed on the field, and will leave untouched much grass which would readily be grazed by older animals.

Continuation of the system to the two-year-old stage has resulted in down calving rotationally-grazed heifers averaging 150 lb. more than their counterpart reared in the ordinary way.

There is as yet insufficient evidence available to give a true picture of how this frequent change of pasture will affect the cow's production. It seems that the butterfat yield will be raised by about 50 lb. per cow over the first lactation, but whether this improvement will persist must await experimental proof.

W.L.

ANIMAL HEALTH

Bovine Mastitis

It is now generally accepted that certain micro-organisms are intimately associated with the occurrence of mastitis in cattle. The disease exists in different forms : that most commonly found in dairy herds is referred to as streptococcal mastitis, because of the presence in the udder of streptococci, the most prevalent being *Streptococcus agalactiae*. Mastitis must be considered an infectious disease, and earlier work in this country showed that it could be controlled by the removal from the herd of infected animals together with taking precautions to prevent healthy animals from becoming infected. Newer methods have been adopted : they consist in the treatment of infected animals by the injection of drugs into the udder through the teat canal. Sulphonilamide gives useful results but the drug of choice is penicillin. The incidence of cure depends upon the dose and on the number of times the penicillin is injected. Many experiments have been carried out in this and other countries and all show the value of penicillin in controlling this type of mastitis. Some recent work indicates that in badly infected herds the daily injection of large doses of penicillin for four or five days, together with thorough disinfection of the premises, milking utensils, equipment and the cows themselves, may result in practically 100 per cent cure. Having cured the herd, precautions have to be taken to ensure that further infection is not introduced. The important source is the infected cow ; thus, in a herd which has been cured, any new arrival should undergo treatment before being added to the herd. In herds in which the incidence of infection is low it may not be necessary to adopt such drastic measures : veterinary surgeons can advise on the method to be adopted. In some herds in which this method of control has been adopted there has been no evidence of infection for periods up to a year ; this is the longest period during which observations have yet been possible.

Other forms of mastitis may not respond satisfactorily to penicillin treatment. It is therefore necessary to establish the type of infection before embarking upon penicillin treatment. "Summer mastitis" associated with the organism *Corynebacterium pyogenes* does not respond well, and other methods of treatment are being studied.

T.D.

ANIMAL NUTRITION

Vitamin Requirements of Pigs and Poultry

The role of vitamins in the nutrition of pigs and poultry has received considerable attention from investigators during the past few years. The requirements of these two types of animals have been investigated, together with possible sources for practical feeding.

Vitamin A deficiency in pigs is of considerable practical importance and is probably more widespread than is commonly realized. Indeed vitamin A deficiency has occurred in pigs where their diet contains a high proportion of feeds deficient in the pro-vitamin carotene.

Ellis, in a review of the vitamin requirements of swine (*Nut. Abs. Revs.*, 16 (1) (1946)), points out that with the limited amounts of yellow maize available in this country it is doubtful whether the level of 30 per cent is sufficient to prevent deficiency. The symptoms of vitamin A deficiency are retardation of growth, swaying gait, fits, paralysis and partial blindness. Braude and co-workers (*Biochem. J.*, 35 (1941), 693) have proposed that 300 I. Units of carotene or 100 I. Units of preformed vitamin A per 10 lb. live weight may be regarded as adequate to meet the minimum requirements of the growing pig.

American workers have re-investigated the requirements of poultry for vitamin A. Recently the National Research Council (U.S.A.) revised the recommended nutrient allowances for poultry in respect of vitamin A. The allowance of 1,200 I. Units per lb. of feed for starting chicks and 1,800 I. Units for growing chicks was raised to 2,000 I. Units of vitamin A per lb. Work by Taylor and Russell (*Poult. Sci.*, 26 (1947), 234) has shown that for pro-vitamin A supplied as carotene and cryptoxanthin from lucerne meal and maize meal, a level of the minimum order of 1,200 I. Units per lb. is necessary as judged by growth-rate, total mortality and age at which egg production begins. For laying and breeding hens, Taylor, Stern and Russell (*Poult. Sci.*, 26 (1947), 243) have shown from a study of mortality, egg production and hatchability that a minimum requirement of 2,000 I. Units of pro-vitamin A per lb. of feed must be supplied. These workers point out that if a margin of safety of the order of 66 per cent is allowed, then their figure would correspond with the National Research Council's allowance of 3,300 I. Units per lb. of feed.

Promotion of rapid growth in pigs is essential, and this must be accompanied by good skeletal development for the production of a well-finished carcass. The role of vitamin D in preventing rickets is closely related to the ratio of calcium to phosphorus in the feed. Aubel *et al.* (*J. agric. Res.* 62 (1941), 531) found that 0.41 per cent of calcium and 0.3 per cent phosphorus with adequate vitamin D permitted good growth in young pigs. In the absence of vitamin D, 0.8 per cent of calcium and 0.5 per cent of phosphorus gave the best results. An intake of 10-20 I. Units vitamin D per 100 g. of feed appears to meet requirements.

Though the requirements of poultry for vitamin D can be adequately supplied in the form of cod liver oil, the question of the stability of the vitamin in mixed rations is of interest. Motyok and Slinger (*Poult. Sci.*, 26 (1947), 86) have shown that the vitamin potency of cod liver oil alone and oil fortified with vitamin D₃ decreased markedly when mixed in a practical poultry ration. The destruction of vitamin D₃ was rapid during the first thirty weeks of storage, amounting to approximately 50 per cent, and 70 per cent of the potency was lost after two years' storage.

Studies on the vitamins of the B complex in relation to pigs and

poultry have centred mainly on factors other than aneurin. However, Van Etten *et al.* (*J. Nut.*, 20 (1940), 607) have demonstrated the essential nature of this vitamin by inducing its deficiency in pigs. The symptoms of deficiency of this vitamin in pigs are interrupted growth, diarrhoea, vomiting, and extreme emaciation. It has been shown, however, by Ellis and Madsen (*J. Nut.*, 27 (1944), 253) that normal American rations contain four to six times the minimum requirements.

The requirements of poultry for riboflavin continue to provide a field of active research. The riboflavin requirement of starting chicks has been investigated by Bolton (*J. agric. Sci.*, 34 (1944), 198), who showed that the inclusion of 5 per cent dried liver meal or 10 per cent dried skim milk prevented deficiency of this vitamin. Further work, using pure crystalline riboflavin, was carried out by the same author (*J. agric. Sci.*, 37 (1947), 316), who showed that the minimum requirement of riboflavin for the prevention of curled toe paralysis was 3.6 μ g. per g. of feed but for full wellbeing of the chick 4.0 μ g. per g. of feed was required. These figures are approximately 20 per cent higher than the figures given by American workers.

The losses to poultrymen from embryonic mortality of chicks have been stated to be second only to the loss from disease. In view of the fact that under present conditions a large percentage of the protein in poultry feeds is of vegetable origin, the likelihood of high embryonic mortality or poor hatchability has increased considerably. The importance of riboflavin in promoting high hatchability is well known. In this respect work by Peterson, Lampman and Stamberg (*Poult. Sci.*, 26 (1947), 187) has shown that the requirement of breeding hens for riboflavin is of the order of 3.6 μ g. per g. for maximum hatchability. This figure is considerably higher than the recommended nutrient allowance given by the National Research Council of U.S.A. (1944). Indeed it would appear from this work that the requirement of breeding hens is the same as that of starting chicks, so that inclusion of liver meal or dried skim milk at the same level as starting chick rations would be necessary for maximum hatchability.

The requirements of pigs for another member of the B complex, nicotinic acid, have been investigated by Braude *et al.* at the National Institute for Research in Dairying. (Braude, Kon and White, *Biochem. J.*, 40 (1946), 843.) These workers recommend a daily allowance of 8 to 10 μ g. of nicotinic acid for normal growth. It was also found that pigs continue to grow in the absence of nicotinic acid when they have reached a live weight of 150 lb.

Shortage of high protein feeds of animal origin has led investigators to examine the possibility of rearing chicks on all-plant rations. Attempts by American workers to achieve this have shown that chicks will not grow on such rations (Rubin and Bird, *J. biol. Chem.*, 163 (1946), 387). These workers have shown that the addition of cow manure to such rations in place of animal protein resulted in normal growth and showed that the factor involved could not be identified with previously known chick growth factors.

R.G.B.

DAIRY HUSBANDRY

Weaning Calves and Lambs. Importance of Grazing Management and Care against Internal Parasites. Gerring, J. C. *N.Z. J. Agric.*, 75 (1947), 603.

Over a period of seven years, Jersey and Jersey-cross calves consistently grazed on fresh pasture were 51 to 126 lb. (seven-year average of 76 lb.) heavier at 9 months than animals allowed to remain on grassland until it became unsatisfactory (so-called set-stocking). The former animals produced 905 lb. more milk (including 58 lb. butter fat) than the latter in their first lactation.

How to Rear Well-grown Dairy Heifers. McMeekan, C. P. *N.Z. J. Agric.*, 77 (1948), 139.

Suggestions are made for putting into practice the results of the above experiment (see preceding abstract). Rotating the young stock around the same pastures as used by the milking herd is recommended, preceding the dairy herd all the time, and with regular and frequent moves every few days, beginning as soon as the calves are 1 month old.

Preservation of Separated Milk for Calf Feeding. McClymont, G. L. and Paxton, R. P. *Agric. Gaz., N.S.W.*, 58 (1947), 607.

When 1 part of formalin was added to 1-2,000 parts of separated milk (i.e., $1\frac{1}{2}$ to 3 tablespoonfuls to 10 gal.), the milk kept up to 10 days without clotting, putrefying, or affecting the palatability of the milk to calves.

The Effect of the Preparation of the Cow on the Rate of Milking. Smith, Vearl R. and Petersen, W. E. *J. Dairy Sci.*, 31 (1948), 589.

In a short-term experiment with four machine-milked cows, it was found that if cows accustomed to washing immediately prior to milking were milked without the washing, the start of milking was delayed by 30 to 60 seconds. Once these unwashed cows had let down their milk, they milked at the same rate as the stimulated group, though the total duration of milking was longer because of the slow start. There was no difference in milk yield between the two treatments. One cow was milked without prior washing for a period of ten days; the results were identical with the first experiment.

Relation of Management to the "Let-down" of Milk. Knoop, C. E. *J. Dairy Sci.*, 31 (1948), 694.

A short report of experiments on the effect of management on the rate of milking is presented. The author concludes that variations in the udder-washing water of from 50° to 130°F. did not affect the rate of machine milking, which he suggests is controlled by the anatomy of the cow's udder.

The Effect of Time of Milking after Milk Secretion on Total Milk Production. Ward, G. M. and Smith, Vearl R. *J. Dairy Sci.*, 31 (1948), 694.

Cows conditioned to 'let-down' or 'excrete' their milk on washing with hot water had two quarters of their udder milked two minutes after washing and the other two quarters milked 4, 8, 16 or 20 minutes after washing. Where the interval was 16 or 20 minutes the yield was significantly lower than the control quarters, whereas the differences on the 4- and 8-minute treatments were not significant.

The Value of Oxytocin for Reducing Fluctuations in Milk and Fat Yield during Experimental Periods. Adams, H. P. and Allen, N. N. *J. Dairy Sci.*, 31 (1948), 662.

The authors point out the difficulty of obtaining significant differences in milk yield when experimental treatments produce very small effects on yield of milk and fat. This is due partly to the fact that the normal day-to-day variations in fat and milk yield tend to mask any experimental effect. As it is thought that daily variations are due mainly to variations in the completeness of milking, an attempt was made to eliminate this error by milking a second time after an intravenous injection of "Pitocin" and in this way removing the residual milk. The results were not promising, as the daily variations in total yield (normal plus residual) were not less than the variations in the normal yield. When the residual milk was obtained after each milking for 10 days, there was a significant increase in total fat and total milk yield, though fat percentage was not affected.

Residual Milk. Dodd, F. H. and Foot, A. S. *Agriculture*, 55 (1948), 238.

Figures are presented to show that normal milking removes only about 80 per cent of the milk and less than 50 per cent of the fat present in the gland when milking begins. These figures were obtained by recovering the residual milk remaining in the udder after machine milking by milking a second time after an intravenous injection of "Pitocin". The experiment was carried out with 8 carefully milked cows over a period of 16 weeks. It is shown that the residual milk obtained is at the expense of a corresponding reduction in the milk and fat yield of the next milking. The authors point out the value of using this method of obtaining residual milk in carrying out research into methods of milking. They suggest that measurement of the efficiency of the removal of milk is likely to give significant results when measurement of the treatment effect on normal yield would be insignificant.

Transferring Feed into Milk. Turner, C. W. *Brit. Guernsey Breeders' J.*, 2 (1948), 3.

The author discusses factors affecting the conversion by the cow of maximum amounts of roughage into milk. He points to the part the mouth, teeth, lips and tongue play in gathering, conveying and masticating the fodder. The importance of the salivary glands and saliva.

secretion is stressed. The function of the reticulum and the rumen is then explained and a special mention is made of the gas production in the rumen and its elimination by belching. Interference with the latter reflex is said to be the cause of bloat. Grazing habits of cows are briefly discussed.

General Principles of Animal Improvement. Nichols, J. E. *Brit. Agric. Bull.*, 1 (1948), 3.

The aim of improvement should be the raising of the average production. Enhanced performance implies a better fitting of improved genetic type to appropriate environment. In improving animals a combined approach is essential. It must take breeding, feeding management and disease control into account. One might concentrate on one factor at a time but one should not lose sight of the others. Difficulties involved in stocking new areas and in grading up are briefly discussed.

Upward Steps in Herd Improvement. William, G. A. *Hoard's Dairyman*, 93 (1948), 774.

Looking back on the improvement in milk production attained in the United States between the years 1930 to 1945, the author formulates the goal to which herd improvers should strive : reasonably high production, long-living cows, weeding out low producers, regular calvings, and the use of proven good sires.

Oestrogens in Grass and their Possible Effect on Milk Secretion. Bartlett, S., Folley, S. J., Rowland, S. J., Curnow, D. H. and Simpson, S. A. *Nature*, 162 (1948), 845.

A preliminary communication reporting on an observed oestrogenic activity of growing herbage of English dairy pastures. The increase in milk yield observed when the cows go out to grass in the spring might be due to the presence of oestrogens in young growing herbage. An improvement in the quality of milk may also result from an intake of oestrogens under suitable conditions. Further experimental work on these lines is proceeding.

Estimating the Amount of Feed derived from Pasture by Cows in the Connecticut Dairy Herd Improvement Association. Frick, G. E. and Eaton, H. D. *J. Dairy Sci.*, 31 (1948), 355.

By using Brody's formula :

$$\text{Dairy-merit ratio} = \frac{340 \times \text{lb. 4\% fat-corrected milk produced}}{1,814 \times \text{lb. total digestible nutrients consumed,}}$$

the mean percentage daily merit for each month of lactation has been estimated on the basis of milk produced and food consumed when receiving nearly all nutrients from hay silage and concentrates. Hence a consideration of input-output relationships throughout the years makes possible an estimate of T.D.N. contributions of pasture. It is suggested that the method may be used as one means of evaluating pasture for milking cows.

Thyroprotein . . . for my pure breeds? What about the long-time effects? Hyatt, G. Jr. and Henderson, H. O. *Amer. Guernsey Breeders' J.*, **73** (1948), 2479.

Based on experience from feeding tests in which 4 Holstein and 4 Jersey cows were fed thyroprotein during at least two successive lactations, the authors call for caution in the use of this material.

After stressing the point that the data are only preliminary and the conclusions tentative, the authors recorded udder trouble, difficulties in reproduction, and very considerable loss of flesh as possible complications following the feeding of thyroprotein.

Comparative Antirachitic Values of Field-cured Hay, Barn-dried Hay, and Wilted Grass Silage for Growing Dairy Calves. Moore L. A., Thomas, J. W., Jacobson, W. C., Melin, C. G. and Shepherd, J. B. *J. Dairy Sci.*, **31** (1948), 489.

A crop of lucerne was harvested simultaneously as field-cured hay, barn-cured hay and wilted silage, and then fed to groups of calves, 140 days old, kept in a darkened barn. The calves had previously had their vitamin D stores depleted. The silage, fed as sole roughage at the rate of 3-4 lb. per 100 lb. bodyweight, produced better live weight gains than either of the hays, and prevented rickets. The barn-cured hay, fed at the rate of 1.2-1.7 lb. per 100 lb. bodyweight, contained sufficient vitamin D to prevent rickets.

A.S.F.

POULTRY HUSBANDRY

Economics

Either the shortage of labour or its increasing cost has greatly revived interest in semi-intensive and intensive methods of poultry keeping. This increased interest appears to be centred mainly on the larger general farms where, under the present arrangements, a large supply of food in the form of grain is no longer a limiting factor. Some interest, therefore, is attached to "Studies of Post-War Costs of Poultry Production" in the *Harper Adams Utility Poultry Journal*, **33** (July, 1948), 46-53. In this account Temperton gives some useful information on the capital costs of intensive methods and the cost of operating them, and draws attention to the large increase in capital costs compared with those pre-war; his estimate for the charge per cage, including a proportionate cost of the building, approximates 45s. He assesses the cost of buying in mature pullets at 25s., and demonstrates that the experiment which he carried out involved a loss of approximately 2s. per cage, though there would have been a profit of a little over 9s. had there been no mortality. It is pointed out, however, that if no charge were made for labour, the labour income would have amounted to 19s. per cage on the mortality experienced.

Rearing

An interesting paper dealing with intensive rearing methods is given by Winter and Schlamb, *Poult. Sci.*, **27** (Sept., 1948), 571-8. The authors compared the performance records of samples of birds reared intensively with others reared on free range. The results showed

no significant difference as far as bodyweight, food consumption and mortality were concerned during the age period from 9 to 20 weeks. The egg production of the range-reared birds was 41.5 per cent from 21 to 66 weeks, and that of birds reared in confinement was 36.6 per cent. Mortality during the laying period in the range-reared stock was 11.3 per cent, and for the other group 21.5 per cent, but no difference was observed in hatchability of fertile eggs from either group; the eggs from the range-reared stock were a little larger. Although, apparently, the authors take little account of the differences in the mortality rates during the laying period, the materially higher figure of that of the group reared in confinement seems to add point to the often expressed view in this country that breeding stock should not be reared in batteries.

Feeding

In the same journal (pp. 531-5) Vondell, in a paper: "Methods of Feeding Layers and Breeders," refers to a two-year experiment in feeding with all mash, scratch feed and mash, and free choice of mash and hard grains. The results indicated that egg production was approximately the same under the different methods of feeding, although all mash gave the lowest mortality. Apparently hatchability was not affected.

Feeding is also a subject of two interesting papers dealing with amino acids. These protein constituents are now frequently the subject of research projects, and knowledge of those required in poultry feeding is increasing rapidly.

Cravens gives an account of the "Effect of Leucine on Egg Production and Hatchability" in *Poult. Sci.*, **27**, (Sept., 1948), 562-70. He points to the evidence supporting his view that leucine is an essential in the diet of laying hens. The requirement appears to be 1.35 per cent of the ration. Normally a sufficient quantity of leucine will be supplied in the whole wheat proportion of a diet fed at normal rates. The arguments in this paper again support the inter-relationship of some amino acids and certain vitamins.

On similar terms is a paper by Jeppeson and Grau (*Ib.* 588-90) entitled "Whole Wheat Protein as an Amino Acid Source for Chicks". The writers show that with young chicks fed whole wheat protein at the rate of 20 per cent in a diet, most of the known amino acid requirements are met. The exception is lysine, and a supplementary addition is necessary to ensure optimum growth—the wheat protein furnishing only about half the requirement at the rate fed. Lysine is found in blood meal, meat meal, peas, and beans.

An extremely useful pamphlet, Circular No. 788, "Nutritive Requirements and Food Formulae for Chickens," Bird, H. R. (Feb., 1948), has recently been published by the U.S. Department of Agriculture. It gives a concise account of the requirements, with particular reference to the vitamins necessary.

A paper with perhaps an interest only for the future: "Feeding Thyroprotein and Sex Hormones to Laying Hens" (Turner, *Poult. Sci.*, **27**, 613-20), concerns an extremely interesting line of research.

The author points out that the egg production of a bird is seasonal and progresses in cycles. If this production curve could be flattened out and sustained at the highest level it would be of great economic value. Turner visualizes as an ideal a high consistent production with a slow moult not interfering with that production. He goes on to point out that generally the cycles of production are believed to be controlled by hormone secretions, and the latter are influenced by temperature and light. Turner concludes that his ideal could be reached if the necessary hormones could be fed in the right proportion. The one with which he is concerned, thyroprotein, provides a uniform level of thyroid hormone in the blood and is one step in the direction of reducing seasonal variation. Although he specifies some of the difficulties, this is a line of research work which, clearly, may be of great commercial value.

R.C.

CROPS AND PLANT BREEDING

Milling Quality of Scandinavian Wheats

Grittiness in wheat flour is a favourable property from the miller's point of view, a gritty flour tending to run like dry sand, while a non-gritty flour tends to form lumps. By milling and sifting in the laboratory, Berg (*Cereal Chem.*, **24** (1947), 274-83) has shown that grittiness (high proportion of larger particles) is a varietal characteristic, not related to protein content. He worked with Scandinavian varieties; in winter wheat, *Eroica* was found to be satisfactory and *Virtus* unsatisfactory. *Eroica* can transmit its satisfactory grittiness, for two out of three lines tested from a cross between *Eroica* and *Virtus* resembled *Eroica* in this respect. The spring wheats tested (*Fylgia*, *Atle*, *Progress*, *Brons*, *Kärn*, *Diamant II* and two new selections) were all satisfactory except *Fylgia*. The independence of grittiness and protein content was shown not only in these tests but also in nitrogenous manuring trials with winter and spring wheats. Grittiness is related to percentage of vitreous grains, which in turn seems to be dependent on a higher proportion of small starch grains. Examination of the pedigrees of the wheat varieties tested suggests that the satisfactory varieties derive their grittiness from the old Canadian variety, *Red Fife*, or related wheats.

Breeding Methods for Perennial Forage Crops

Conclusions of great importance for breeders of perennial forage crops are contained in a report by Tysdal and Crandall (*J. Amer. Soc. Agron.*, **40** (1948), 293-306) on the polycross method of selection in lucerne. In this method selected plants are propagated by cuttings and the clones thus produced are grown together in isolation so as to produce seed by natural intercrossing. Seed of the different selections is harvested separately and used for progeny testing. The authors show that this method gives reliable estimates of the breeding value of selections both in respect of yield of forage and of such important characteristics as resistance to bacterial wilt, leaf-hopper damage and cold injury. Incidentally they also show the importance of selecting for low self-compatibility if the maximum yields are to be obtained.

Inactivation of Hormone Weed-killers

Lucas and Hamner (*Science*, **105** (1947), p. 340) showed that a proprietary activated charcoal was capable of inactivating the hormone weed-killer 2,4-D, and Weaver (*Bot. Gaz.*, **109** (1947), 72-84) showed that certain proprietary ion exchangers had the same property. More recently Weaver (*Bot. Gaz.*, **109** (1948), 276-300) has reported an extensive series of experiments in pots and in the field in which the protective action of activated charcoal and a cation exchanger against 2,4-D and similar products was studied. Mixed with soil both were found to be capable of protecting bean (*Phaseolus*) plants; the charcoal preparation, which was much more effective, could also protect mustard seedlings. The rate per acre required with the cation exchanger was much too high for economic use (about 50,000 lb./acre) while that of the activated charcoal was about 500 lb./acre. It was also found possible to protect plants from sprays or dusts of hormone weed-killers by a preliminary spraying or dusting with activated charcoal or cation exchanger, though the "contratoxicants," as Weaver calls them, could in some circumstances produce injury themselves. Arle, Leonard and Harris (*Science*, **107** (1948), 247-8) have also reported successful results with activated charcoal in the case of sweet potatoes. Plots were treated with sodium 2, 4-D at rates sufficient to control many annual weeds. Half of each plot was planted with untreated sweet potato sprouts, the other half with sprouts which had been moistened and dusted with activated charcoal. This was found to have a strong protective action. There appears, therefore, to be some prospect of extending the range of usefulness of these selective herbicides and of controlling their unwanted effects on sensitive crops either following in the rotation or exposed to wind-blown spray or dust.

Dormancy in Grain

Hutchinson, Greer and Brett (*Emp. J. exp. Agric.*, **16** (1948), 23) have reported preliminary investigations on the resistance to sprouting of wheat varieties grown in Great Britain and of some new wheat selections from the Cambridge Plant Breeding Institute. Tests with ears taken from a mature crop and sprayed heavily in the open air for 2 hours three or four times a day for seven days showed that *Holdfast*, *Steadfast* and *Juliana* were very susceptible to sprouting, *Warden*, *Victor*, *Little Joss*, *Weibull's Standard*, *Redman*, *Squarehead's Master* and *Yeoman* were intermediate and *Scandia*, *Jubilégem*, *April Bearded*, *Atle* and *Hen Gymro* were resistant; in another test *Scandia* was intermediate. The Cambridge selections were represented in all three groups. Threshed grain sown in pots and kept besides the ears gave much higher germination, as did germination tests in the laboratory at 15°C., which indicated that, possibly, the ear had some restrictive influence. When the laboratory germination tests were carried out at 23° C. the varieties again fell into the three groups, though on this basis *Yeoman* and *Squarehead's Master* would appear to be resistant.

Brown *et al.* (*U.S. Tech. Bull.*, No. 953 (1948), 3), have studied dormancy and the effect of storage in oats, barley and sorghum. They also found the best measure of dormancy to be reduced or delayed

germination of newly harvested grain in tests at high temperatures. In both oats and barley they found that winter varieties showed dormancy more frequently than spring varieties. An effective treatment for reducing dormancy was storage for two months at 104°F. Storage at 36°F., even when prolonged, was much less effective, especially with oats. The different effects of the two temperatures were shown to be not the result of drying the grain to different extents. Consistency in the behaviour of varieties grown at different places and in different seasons showed that dormancy is a varietal character. The lists given by the authors of their most dormant varieties should be valuable to oat and barley breeders.

Plant Growth Controlling Substances

The range of effects produced by these substances does not seem to be exhausted. Green and Fuller (*Science*, **108** (1948), 415) have shown that plants to which indole-3-acetic acid is applied by immersion of the roots in a 200 p.p.m. solution, are delayed in flowering without any evident deformities such as are produced when the hormone is applied as a spray. Young inflorescences of various ornamental plants, which were cut and treated by dipping the cut ends in the solution, also showed delay or inhibition of bud opening. Fults and Schaal (*Science*, **108** (1948), 411) applied the sodium and ammonium salts of 2,4-D and the butyl ester to a growing crop of *Bliss Triumph* potatoes. Whereas 20 lb. per acre of the acid equivalent applied as a side dressing, when the tubers were about one-third formed, caused no apparent injury or reduction in yield, similar dressings at 200 and 400 lb. per acre caused serious injury and reduction in yield. All rates increased the amount of red skin colour, though no change in flesh colour or flavour was noted.

With plants susceptible to "hormone" weed-killers, e.g., the French bean (*Phaseolus vulgaris*), it has been reported that seed produced on treated plants may be adversely affected. It is important, therefore, to know whether such an effect occurs with more resistant plants which may be submitted to similar weed control treatment. Marth, Toole and Toole (*J. Amer. Soc. Agron.*, **40** (1948), 916) sprayed American ryegrass plants in the greenhouse (i) when the spike primordia were just forming in the base of the tillers, (ii) when the plants were shooting, and (iii) when the seed was developing; the rate of application corresponded to 1.7 lb. of 2,4-D per acre. The seed produced germinated 97-98 per cent, and no effect of the treatments was detectable. Field experiments with oats, rye and wheat gave inconclusive results, as even untreated plots gave seed of low germination and poor quality. Again, however, no effect of the treatments could be detected.

Plant Identification

The following two recent publications will be found useful by those who are frequently being asked to identify plant material:

(i) EARNSHAW, F. *A Description of the Recommended Varieties of Wheat and Barley*. Nat. Inst. Agric. Bot., Cambridge: p. 79 (undated, appeared in 1948).

(ii) MUSIL, A. F. *Distinguishing the Species of Brassica by their Seed*. U.S. Dept. Agric. Misc. Publ., No. 643 (1948), p. 35.

J.L.F.

VEGETABLE CROPS

Problems in the Cultivation of Winter Lettuce. Brown, W. and Montgomery, N. *Ann. appl. Biol.*, 35 (1948), 161-80.

The following results and conclusions were obtained from a four-year study of winter lettuce cultivation at Slough. The varieties, *Imperial* and *Majestic* (a strain of *May King*), were found to be the best of five which were tried. *Majestic* matured a few days earlier than *Imperial*, but in a dry spring many plants were not big enough. A fault with *Imperial* was that late-maturing plants did not heart properly. Plant survival of *Arctic* was as good as *Imperial* and *Majestic* but mature plants were too small. *Improved Unrivalled* had an inferior survival and hearted too late and unevenly. *Trocadero Improved*, which is not a winter lettuce, was inferior, mainly because of its susceptibility to *Pythium* root rot, which resulted in severe thinning of seedlings and dwarfing of many survivors.

The most valuable crop was that obtained from November planting (following the crop matured under glass), provided the final stand was reasonably good. *Botrytis cinerea* was the all-pervading fungus which determined the ultimate stand of winter lettuce. On the average, plants required for transplanting in November should not be sown in outdoor seedbeds later than the second week of September; later sowings give a poorer ultimate survival than earlier sowings. Moreover, with the same planting date in November, early sowing in September gives 3-4 days' advance in the date of maturity over later sowing in September. Late-autumn plantings overwintered better on a medium-heavy loam than on a light sandy soil.

Early spring planting from seedbeds sown in the latter half of September provides a succession of early lettuce crops. It is important that the spring planting should be done at the earliest moment—in February if possible. Delay means delay in maturing, together with the risk that some plants will run to seed without hearting properly. The crop treated in this way will reach maturity about 10-11 days later than November-planted crops from early September sowing.

Considerable variation was found between different pieces of land in their capacity to provide good stands of seedlings in early spring. Seedbeds prepared in the form of a series of ridges with seedlings grown in the hollows of the ridges had a lower percentage of diseased plants than those grown on the top of the ridges. Sowings on the flat tended to behave in an intermediate manner. The prospect of survival to maturity of spring-planted seedlings was much improved by a single fungicidal treatment (chloronitrobenzene dust) at the time of transplanting.

These findings show that improvement can be made on this method of culture, but further research is necessary before exact recommendations can be made.

ABSTRACTS : NUTRITION OF HORTICULTURAL CROPS

The Use of Chemicals for the Control of Weeds in Carrots.

Nyland, R. E., *Proc. Amer. Soc. hort. Sci.*, 49 (1947), 332-8.

Several chemicals were sprayed on carrots at the three- to four-leaf stage and of these Stoddard Solvent, applied once at the rate of 80 gallons per acre, gave the best control of weeds without reduction in yield. All the chemicals tested, including Stoddard Solvent, reduced the yields when applied more than once. Off-flavour of carrots caused by the application of Stoddard Solvent was detectable 39 days after spraying but was not detectable 52 days after spraying.

[NOTE: *Stoddard Solvent* is a term applied to an American specification for petroleum oils used as dry-cleaning fluids and paint thinners. Oils of precisely this specification are not available in this country, the nearest being *Pool White Spirit*, which under trial has given results as a carrot herbicide comparable with *Stoddard Solvent*—Ed.]

Weed Control in Cannery Peas, using Dinitro Sprays. Warren, G. F. and Buchholtz, *Proc. Amer. Soc. hort. Sci.*, 49 (1947), 347-50.

Dow Selective Weed Killer (ammonium salt of dinitro ortho secondary butyl phenol) when sprayed on a crop of cannery peas which was heavily infested with weeds, at a concentration of either 3 or 4 pints per 100 gallons of water, brought about a large and highly significant increase in yield of shelled peas, as compared with untreated plots. Also, certain concentrations of Sinox (sodium dinitro ortho cresylate) used as a spray brought about increases in yield but of a lower order than that obtained with Dow Selective. Sinox gave as good weed control as Dow Selective; the poorer yield results with Sinox appeared to be a consequence of the greater amount of growth injury caused by this spray.

J.P.

NUTRITION OF HORTICULTURAL CROPS

Significance of Zinc as a Nutrient in Horticultural Crops

Zinc is a plant nutrient which has been proved to be necessary for the growth of both annual and perennial crops. When the supply of zinc is deficient or unavailable to the plant, certain types of fruit trees become chlorotic and develop a growth habit known as "little leaf," whereas when the supply is in excess a different form of chlorosis occurs, which is attributable to iron deficiency involving the immobilization of the iron by the zinc in the tissues. The following four papers indicate different advances in the study of the correction of these disorders in the field.

Zinc Treatment for the Control of Rosette or Little Leaf of Fruit Trees. Lindner, R. C. *Proc. Wash. St. hort. Ass.* (1944).

It was found in America during 1931-32 that the condition of "rosette" in apple trees could be cured by zinc sprays. This condition

of zinc deficiency is characterized by a chlorosis, small elongated leaves, and a rosette-like appearance of what, normally, would be extension growth. Sometimes, both "rosette" and lime-induced chlorosis are observed on the same tree. It is thought that "little leaf" is caused by a shortage of available zinc in the plant tissues, though other factors, not understood, are thought to be involved. "Rosette" has been observed in commercial plantings of apples, pears, cherries, plums, peaches, and apricots. Although an effective control measure consists in planting lucerne in the orchards, the lucerne is eventually killed by the lead arsenate sprays. Successful control of "rosette" is obtained by spraying the trees in the dormant stage with a 5 per cent solution of zinc sulphate (50 lb. per 100 gallons of water). If the condition is severe, spraying has to be carried out for 2-3 years. Applications of zinc sulphate to the soil have not proved successful. Injection of zinc salts into the trunks of trees is effective but causes considerable injury to the bark.

Zinc Deficiencies of Fruit Trees in Europe. Mulder, D. *C.R. Acad. Agric. Fr.*, **34** (1948), 177-8.

Recent evidence obtained in Holland shows that zinc deficiency in apple, pear and cherry trees occurs in the south-east of Holland on neutral or alkaline silt soils. The symptoms noted on the variety *Golden Delicious* are: a chlorosis of the interveinal portions of the leaves, wavy leaf margins, short internodes resulting in "rosettes," abnormal branching resulting in witch's brooms, and smallness of fruits. Some other apple varieties affected are: *Westwick Codlin*, *Cox's Orange Pippin*, and *Jonathan*. Remarkable recovery was observed after spraying the trees in winter with 5 per cent solution of zinc sulphate and in summer with a $1\frac{1}{2}$ per cent solution containing 0.75 per cent of lime. A similar deficiency is reported from Denmark and Switzerland.

Nickel and Multiple Trace Element Deficiencies in Crops. Barclay, C. and Roach, W. A. *Nature*, **157** (1946), 696.

Field experiments with wheat, potatoes and broad beans, carried out on Romney Marsh in Kent, showed that where manganese, iron, boron, copper, zinc and nickel were sprayed on to the crops, increases in yield were noticed for each of the six elements. The response to zinc sprays was found particularly in potatoes, where increases in yield up to 27 cwt. per acre were obtained by using zinc sulphate. By spraying with both zinc and manganese, increases up to 78 cwt. were obtained, taking the total yield up to 11 tons per acre. These experiments indicate the complexity of zinc deficiency in the field, and demonstrate the responses that can be obtained from multiple micro-nutrient sprays.

Studies in Iron Deficiency of Crops. Wallace, T. and Hewitt, E. J. *J. Pomol.*, **22** (1946).

Chlorosis in fruit trees is a perennial problem with fruit growers. A comprehensive review is given of the subject as it affects the metabolism of iron in the plants. The causes of iron deficiency may be due to (1) deficiency of total and available iron in the plant (probably occurring only in solution or sand cultures), (2) deficiency of available iron known

ABSTRACTS : FRUIT

as lime-induced chlorosis specific to calcareous soils, (3) deficiency resulting from a shortage of other nutrients, especially potassium, (4) deficiency developing from excesses of other nutrients such as phosphorus, manganese, copper and zinc and other heavy metals, e.g., cobalt. These four causal factors are examined in relation to the soil, the environment generally and the plant. Particular attention is drawn to the lack of knowledge relating to physiologically "active" and "inactive" iron in the plant tissues. For instance, when lime-induced chlorosis occurs the total iron in the plant may be more than is actually necessary for normal growth but in some way or other the iron is unavailable. The remedial effect of grassing down orchards affected by chlorosis is discussed but no reasons are advanced. Similarly the accumulation of unavailable iron as a result of excess zinc is described for both field and laboratory conditions. In the field zinc occurs in veins in the dolomitic limestone (Mendip area), and where arable fields are present acute iron deficiency can occur as a result of the immobilization of "active" iron in the tissues. Grassing down or liming are practical ways of overcoming the trouble.

Determination of Factors Injurious to Plants in Acid Soils. Wallace, T., Hewitt, E. J. and Nicholas, D. J. D. *Nature*, **156** (1945), 29.

The causes of crop failures on acid soils are possibly due to (1) injury to the root system by hydrogen ions, (2) shortage of calcium as a plant nutrient, (3) the presence of unavailable phosphate, (4) excess of soluble aluminium and manganese, and (5) biotic factors (for example, absence of soil micro-organisms). By the use of sand culture experiments, and the chemical analysis of the plant, experiments were devised using the cauliflower as one of the indicator plants to study the factors involving a shortage of calcium and an excess of manganese. When the cauliflower is deficient in calcium, the young leaves are distorted, and sharply hooked backward or forward. In the presence of high amounts of manganese, leaves become cupped and the margins incurled and eventually show necrotic spots. The effect of increasing the aluminium in the plant does not alter the shape of the leaves although growth is restricted and the plant takes on the appearance of phosphate deficiency. In the field the symptoms of manganese excess and calcium deficiency can be identified with those produced in these sand culture experiments.

W.P.

FRUIT

The Oeschberg Pruning Method

The chief characteristics of apple trees pruned by the method developed by Hans Spreng at Oeschberg in Switzerland are that each tree is composed of a central leader with four well-spaced branches arranged around it, and the crop is borne mainly on lateral growths from the central leader and from the undersides of the branches. Considerable attention has to be given to pruning and training while the trees are

young, but once the trees are formed they are long-lived and require little labour for pruning. The method is much favoured in Switzerland, especially for standard trees, and has been described in various publications. The summary given here is based on the description by J. Jans, in *Schweiz. A. Obst-u Weinb.*, 56 (1947), 449-60.

The tree consists of a central leader, main branches, fruit branches and fruiting wood. The central leader carries a tier of four main branches at a suitable height from the ground, the points of origin of these branches being not too close together. In some cases it may be best to form some of the branches in one year and some in another. They should form a wide angle (40-45 degrees) with the central leader, and this is achieved by pushing the branches apart by temporary struts and by hard pruning. This hard pruning also assists in furnishing the branches with laterals. The central leader should itself be well furnished with fruiting wood in its lower part and fruit branches higher up, but these should never be allowed to compete with it or the main branches. Actually Jans prefers to have the main branches of a young tree too steep rather than too flat, since this fault can easily be corrected later by pulling them down ; in this the weight of fruit also assists. Varietal habit should, of course, be allowed for ; thus *Belle de Boskoop* has a flat habit and cannot be built too steeply. Sometimes there may be room to form further main branches higher up the central leader where there are gaps between those of the first tier, but a proper second tier should not be formed.

The main branches should not be allowed to fork and should always be subordinate to the central leader in vigour. Along their undersides they should bear fruit branches at intervals of 40-80 cm., according to variety, vigour, etc., and between these and along them fruiting wood is encouraged. Along the upper side of the branches some of the weaker shoots may be left to develop into fruiting wood.

The fruit branches should grow slightly upwards at first, and later their tips should be more upright. They may become long and strong but they must always be subordinate to the branch leaders. On the main branches they should be formed only on the undersides, though they may be a little to one side or the other. Shoots destined to form fruit branches should be pruned to encourage further growth. There is no general rule as to their number and spacing, but in a young tree and in the upper third of the leader and branches it is better to prune too many shoots than too few, for any not required to form branches can later be left unpruned and tied down to form fruit wood. In any case the first shoot below the leader should be cut back to one or two buds, even if not required as a fruit branch. The definite selection of fruit branches should not be left later than in the third- or fourth-year-old wood, and as a rule the branches should occur every 40-80 cm. Fruit branches formed close to the origin of the main branches encourage good secondary thickening of the central leader. In later years, if new growth on any main branch and its fruit branches becomes insufficient, the pinching out of the apical buds of the branches and fruit branches is said to encourage further extension. The general aim is to make the fruit branches strongest towards the base of the main branches, so that

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the tree in outline is concave and the fruit branches in the upper parts neither crowd the leader nor overshadow the lower branches.

The fruiting wood is formed on the central leader and main branches by tying down to a horizontal position one-year-old shoots that are not needed to form fruit branches. After tying down, the terminal bud is removed. In the following year the new growth on these shoots is not again tied down but is cut back to its base with the object of obtaining extension growth, the process being called "rejuvenation". Subsequently, the shoot produced at the cut is left untouched except for the removal of the terminal bud. This whole process helps to maintain a balance between the amount of fruiting wood, fruit branches and main branches and to achieve a better production of fruit wood.

In general, pruning is reduced to the minimum necessary to build up the tree and the only one-year-old shoots to be cut are the terminal growths of the central leader, main branches and future fruit branches. All the other one-year-old shoots are removed completely, or left unpruned.

This method of pruning has not yet been tried out in this country, and it is impossible to forecast what results it would give. The claim that it reduces the labour of pruning, once the tree is formed, is very attractive, for the provision of skilled labour for pruning is becoming a difficult problem.

H.B.S.M.

FLOWERS

Breeding of Ornamental Plants. Emsweller, S. L. *Proc. Amer. Soc. hort. Sci.*, 51 (1948), 565-74.

Most of the numerous varieties of flowers and ornamental plants now available to the horticulturist have been developed by amateurs, flower seedsmen and nurserymen. Many of the best varieties were introduced before 1900 and therefore preceded the era of Mendelian genetics. It is only in comparatively recent years that planned breeding of flowers has been carried out.

This paper is an admirable summary of the methods of approach to the problems of production of new varieties and makes valuable suggestions for new lines that might be worth following. The author points out that the breeder's problem is essentially one of producing varieties suitable for different regions, involving considerations of different photoperiods, temperatures, soils, moisture, and disease and insect resistance. He pleads for trials of new forms in a variety of different areas, since a plant which may be discarded as valueless in one region may prove to be a "winner" in another.

He discusses the technique of flower breeding under three heads : (a) sexually propagated plants, (b) plants propagated by asexual means, and (c) induced polyploidy.

Under the first heading, high fertility is a prime requisite. It is important, also, that a new variety should be reasonably homozygous

for flower colour, height, time of flowering, and flower quality. The author stresses the need for a period of inbreeding to establish this homozygosity before breeding, otherwise much time may be lost ; for example, with a plant where red flower colour is incompletely dominant to white, an attempt to select and purify a pink strain is a waste of time.

In the raising of seed of stocks (*Mathiola incana*) he suggests the establishment of a perennial stand of ever-sporting singles, for by this means it should be possible to obtain far higher seed yields with freedom from the trouble of continued selection and the worry of uncertainty as to the percentage of doubles.

The phenomenon of hybrid vigour should be much more used, and in this connection it should be remembered that the more unlike the parents the greater the probability of first-cross vigour. Thus greater vigour is to be expected from a cross between a tall and a dwarf antirrhinum than from two tall.

Among vegetatively propagated plants the author suggests, *inter alia*, the need for much more research into the mode of origin of sports, and investigations into the uses of synthetic hormones for overcoming self- and cross-incompatibilities.

In the field of colchicine-induced polyploidy the author stresses the need for establishing homozygous strains before doubling, otherwise the problem of fixing a new form will be much greater. He also points out that induced polyploids should be looked upon as the raw materials for further breeding, rather than as finished products.

Day-Length and Flower Bud Development in Chrysanthemums. Post, Kenneth. *Proc. Amer. Soc. hort. Sci.*, 51 (1948), 590-2.

Working with midseason and late varieties, the author concludes from this and earlier studies that chrysanthemums can initiate flower-buds when the day-length falls to 14-14.5 hours (including the period of civil twilight), but that most rapid flower-bud development does not occur until the light period is 13-13.5 hours. This is important in connection with attempts to hasten the blooming of chrysanthemums by artificially shortening the day-length or in prolonging the season of flowering by delaying flower-bud formation with artificial light to increase day-length. The author points out that only in exceptional seasons will the actual average day-length in autumn approximate to the theoretical maximum.

Rooting Evergreen Cuttings with Hormones. Myhre, A. S. and Schwartze, C. W. *Proc. Amer. Soc. hort. Sci.*, 51 (1948), 639-50.

Experiments were carried out with 24 species of evergreens, including cypress, arbor vitae, juniper, yew, holly, box, and others, to test the effectiveness of indolebutyric acid and naphthalene-acetic acid in solution and in powder form in stimulating rooting of cuttings propagated in sand and in mixtures of equal parts of sand and peat.

Cuttings of laterals were taken in late October and early November and rooted in propagating cases with a bottom heat of 70°F. The authors conclude that 24-hour treatment with a 60 to 80 parts per

million solution of indolebutyric acid results in a great stimulation of rooting and provides over 90 per cent of successful cuttings. Powder treatments were less effective. No significant differences were noted between results in sand and in the sand-peat mixture.

R.H.S.

MYCOLOGY

Cereal Diseases

During the past season Take-all (*Ophiobolus graminis*) was unusually prevalent and caused considerable concern to farmers. A number of recent papers have dealt with various aspects of this disease.

In Australia, White concluded that the presence of the parasite in a field was dependent upon the latter's previous history. The continual growing of susceptible crops, a light-textured soil, and a high soil nitrogen, all favoured the persistence of the disease. Both the growing of non-susceptible crops and bare fallowing led to the disappearance of the fungus which was also discouraged by a firm seedbed and by increasing the carbon content of the soil. The effect of the disease upon the crop depended upon the plant's ability to produce fresh roots more rapidly than the fungus destroyed them. Root formation was assisted by adequate soil moisture and high soil fertility.

Also in Australia, Angell has given an account of his work on the effect of fertilizers on Take-all in wheat. He found that although the number of plants with root infection was not affected by any fertilizer treatment, the percentage of whiteheads was closely correlated with such treatment. Usually a mixture of ammonium sulphate and superphosphate, with or without trace elements, was beneficial, provided that soil moisture did not limit the growth of the plants.

Somewhat similar results have been published by Garrett. In a field experiment the percentage of infected barley plants was reduced by the application of nitrogen and also by a mixture of phosphate and potash. This result was attributed to the fact that the fertilizers enabled the plants to produce new roots more rapidly than the fungus infected them. In previous pot experiments it had been found that there was no difference between the amount of disease in plants receiving a full supply of complete fertilizer and those receiving one-third of the amount, and that a reduction of the nitrogen only in the complete fertilizer caused a reduction in the amount of the disease. The apparent discrepancy between these results and those obtained in the field was explained by the fact that in the pot experiment the plants were inoculated at the crown, and conditions so favoured the disease that the disease-escape mechanism found in the field did not operate normally. The author concludes that although increased nitrogen increases the susceptibility to infection of individual roots by stimulating growth, it promotes disease-escape and leads to a higher yield.

Garrett and Buddin have given an account of the control of Take-all under the Chamberlain system of barley growing. Under this system spring barley is sown with a seeds mixture of trefoil and ryegrass. After harvest the rapidly growing seeds mixture uses up soil nitrogen thus starving the fungus. After autumn growth has ceased the seeds ley is ploughed in, and the nitrogen thus liberated assists the next barley crop to escape the effect of any fungus which has survived.

Storey has given an account of his observations on Take-all and Eyespot (*Cercospora herpotrichoides*) in Yorkshire. He found that both diseases occurred most frequently where susceptible crops were grown too often. There was less disease after one-year leys when oats were used as nurse crops instead of wheat or barley. He considered that a one-year ley was not long enough to allow either *Ophiobolus* or *Cercospora* to disappear from the soil and suggested that a two- to three-year ley was desirable.

H.E.C.

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ENTOMOLOGY

Earthworms. Evan, A. C. *J. Bd. Greenkeep. Res.*, **8** (1948), 49.

This paper contains interesting information on many aspects of the life and behaviour of earthworms and the effect which these creatures have on soil fertility. There are some 25 species in this country, 10 being fairly common on cultivated land. A good account of the life cycle of earthworms is given, including the surprising information that some species may live for periods varying from 3-10 years. It is stated that worms do not swallow soil particles over 1/12 inch in diameter, hence the layer of stone-free soil 4-8 inches in thickness found in well-established pasture.

Worm casts are produced most abundantly in spring and autumn ; the work at Rothamsted has shown that casting is equivalent to some 11 tons per acre per year. On the subject of populations per acre, figures of 1-3 million are given. Recent estimates by weight from Rothamsted give figures of 2-12 cwt. per acre for grassland.

The Use of Metaldehyde against Slugs. Thomas, D. C. *Ann. appl. Biol.*, 35 (2) (1948), 207-27.

A full account is given of further experiments in the control of slugs. The range of attraction of a bran and metaldehyde slug bait has been found to be from 2 to 3 feet at the most. The mortality of slugs attracted by the bait is shown to be dependent on the drying properties of the soil and air around the bait ; under moist conditions the kill is poor.

A new metaldehyde-bran bait, which is compacted into "biscuit" form with the aid of casein glue, is described. These "biscuits" may be broken into a coarse meal and broadcast. One part of metaldehyde to 30 parts of bran is the minimum effective concentration. This type of bait may have great practical value, since it is effective over a longer period than the old type ; the material does not go mouldy and will withstand changes in weather. By its use it may be possible to clear a piece of ground of slugs before planting a crop.

The Biology of the Apple Blossom Weevil. Dicker, G. H. L. *J. Pom. and Hort. Sci.*, 22 (1946), 140-52.

The investigations described in this paper reveal a number of interesting facts concerning this pest. It was found that adult weevils emerge from hibernation over a period of five weeks, beginning at the end of February or in early March ; for activity, however, the maximum daily temperature must exceed 50°F. Adults of the next generation were most numerous in June. Oviposition in the early spring began at the "bud-burst" stage and continued for three weeks, an average of 44 eggs being laid by each female. The numbers of weevils entering sacking trapbands around the trunks of the trees reached a peak in late July or early August.

The Bulb and Stem Eelworm in Relation to Garden Plants. Wilson, G. F. *J. R. hort. Soc.*, 73 (1948), 335-45.

This article, which should prove of special value to horticultural officers, reports that of a total of 329 recorded host plants of this eelworm in the world, 129 hosts are known in Britain. A list is given of the chief hosts among ornamental, fruit and vegetable plants ; excellent descriptions of the symptoms of infection for these hosts are given and there are a number of good illustrations. The question of biologic races is discussed and the host range of a rather specialized strain is compared with that of a more unspecialized race. It is stressed that not all strains are reciprocally infective, the behaviour of a strain being dependent to some extent on its ancestral history. The importance of weeds as bridging hosts is discussed. The principal means of dispersion, such as transmission in, or on, seeds, plants, soil drainage water and by other means, are listed and discussed. Control measures are reviewed under the headings of propagation, cultural, physical and chemical methods.

L.N.S.

VIROLOGY

The Spread of Virus Diseases in the Potato Crop. (A.R.C. Report Series No. 7). Doncaster, J. P. and Gregory, P. H. H.M.S.O. (1948).

This is not a survey of the health of potato stocks but a study of the conditions governing the spread of Leaf-Roll and Rugose Mosaic. A heavy attack of aphides is not necessarily followed by a great increase in the incidence of these diseases; on occasions there is a greater spread of virus in a light infestation than in a heavy one. This suggests that movement of aphides is more important than numbers. The overwintering of aphides is an important point and for the egg stage of *Myzus persicae*, fruiting peaches, both out-of-doors and in unheated glasshouses, are the most frequent hosts. In mild seasons the aphids can persist throughout the year on a succession of brassica crops and even on sugar beet.

An important conclusion is that most of the virus spread is by the winged spring migrants of *Myzus persicae*, rather than the winged dispersal migrants. This has a bearing on the control of potato virus diseases in south-east England because the spread occurs too early for roguing, early lifting, or nicotine fumigation of the aphides to be effective. The main sources of virus infection to a potato crop are the occurrence of infected plants in the parent stock and the presence of diseased volunteer plants.

Virussmittan vid Klyvning av Sättpotatis (Virus Infection through Cutting of Seed Potatoes). Lihnell, D. *Växtskyddsnotiser, Växtskyddanst.* Stockh., 2 (1947), 17-21.

These experiments confirm the evidence obtained experimentally in this country that potato virus X is not spread by means of the knife used to cut seed pieces from potato tubers. Infection may result, however, if a contaminated knife passes through a well-developed shoot.

The X-Disease of Peach and its Chemotherapy. Stoddard, E. M. *Bull. Conn. agric. Exp. Sta.*, 506 (1947), 3-19.

Although this virus disease does not occur in the British Isles, it is of interest as being the first case of the apparently successful chemical treatment of a plant virus disease.

The results of experiments showed that peach trees can be immunized against artificial inoculation of the X-disease by injection of, or watering with, aqueous solutions of various chemicals, most of which give better control when applied after inoculation. Trees treated with sodium sulphadiazine, sodium sulphamerazine, sulphaguanidine, zinc sulphate, hydroquinone and disodium ethylene bis-dithiocarbamate showed considerable immunity 10 months after application.

Woodiness or Mosaic Disease of Passion Fruit. Magee, C. J. *Agric. Gaz. N.S.W.*, 59 (1948), 199-202.

The fact that the passion fruit (*Passiflora edulis*), and incidentally the banana also, is susceptible to infection with Cucumber Mosaic virus serves to emphasize the growing importance of this virus abroad and in this country. This is especially true as regards perennial flowering plants which are gradually becoming infected and so act as a source of virus for many other types of plants.

Aphid Transmission of Lily Viruses during Storage of the Bulbs.
Smith, Floyd, F. and Brierley, P. *Phytopathology* No. 97, **38** (1948), 841-4.

The authors point out the danger of the spread of aphis-borne viruses during storage of bulbs. They also consider that viruses can be carried from the field to the storehouse and from the storehouse to the field when suitable aphis species are present.

Raspberries and Strawberries

A review of some recent research on virus diseases of raspberries and strawberries in Great Britain ⁽¹⁾ shows that even the best strains of *Lloyd George* raspberries are infected with at least two viruses or virus groups. It is also concluded that both raspberry mosaic categories are complex associations of viruses.

As regards strawberries it seems that there are at least two distinct severe Yellow Edge diseases, each caused by not less than two viruses, one of which, the persistent Yellow Edge virus, is common to both. Also it appears that Mild and Severe Crinkle are distinct and unrelated diseases, the virus of the former having short, and that of the latter long, persistence in the aphis vector. Finally, these Crinkle viruses function also as constituents of the two Yellow Edge diseases, Crinkle thus being shown to be related to, and included in, Yellow Edge ⁽¹⁾.

Hops

Mosaic disease of hops has become so destructive in the districts growing the *Golding* variety that many growers have replaced it with the tolerant *Fuggles* hop ⁽²⁾. Control measures recommended are the use of virus-free cuttings and roots: separation of *Golding* yards as far as possible from tolerant varieties: planting of sensitive males only, and frequent and thorough inspection of the hop yards with destruction of the mosaic infected plants as detected.

The spread of hop nettlehead during the last four years is also causing concern. This virus attacks all varieties including male hops and occurs mainly in the vicinity of yard margins in close proximity to hedgerows and trees. It is suggested that certain hedgerow plants may act as symptomless carriers of the virus.

Onions and Shallots

The mosaic disease of onions and shallots, which resembles the "yellow-dwarf" disease of these plants in the U.S.A., has become increasingly serious in England of late years and has also caused economic losses in Scotland, where it was first recognized in 1940. The deterioration of infected plants becomes more marked each season. Control measures recommended are fumigation of the "cloves" by Cyanogas before planting, the removal of diseased plants early in the season and the production of virus-free bulb stocks in areas free of the disease ⁽³⁾. A scheme of shallot inspection has been initiated by the Department of Agriculture for Scotland and it is hoped that in future growers will have their stocks examined for certification. Bulbs grown for this purpose should be planted at least 50 yards from onions, leeks and allied crops.

Lettuce

The virus of Dandelion Yellow Mosaic which is widespread in East Anglia causes severe stunting on lettuces with leaf malformation, particularly in autumn and winter (4). On outdoor lettuces severe necrosis begins usually on one outside leaf and spreads to the heart. Whilst most samples of commercial seed give 2-4 per cent of seedlings infected with lettuce mosaic, no evidence has been obtained of any seed transmission of Dandelion Yellow Mosaic virus.

Broad Beans

An apparently undescribed virus disease of the broad bean has appeared this summer in the Cambridge district. Symptoms consist of a severe mosaic in which dark green blisters develop on a lighter green background. The virus is transmissible to a large variety of host plants, including *Nicotiana* spp. and *Datura* on which it produces a disease of the ringspot type. The virus also infects the zinnia, which seems to act as a symptomless carrier, and nasturtium (*Tropaeolum* sp.). The insect vector, if such exists, has not yet been identified.

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K.M.S.

INSECTICIDES AND FUNGICIDES

Some New Fungicides

At first sight it would appear that as sulphur and copper fungicides are so cheap and effective, any attempt to find substitutes would be a waste of time. But lime sulphur and the dispersible copper fungicides have several disadvantages, of which those arising from their drastic action upon leaf tissue are important. If, as mentioned previously in this REVIEW (No. 2, 1948), methods of application alternative to conventional spraying are to be successful, the materials applied must be sufficiently safe to the plant to permit over-application.

Marsh (*J. Pomol.*, 23 (1947), 185) has reported his tests of some new fungicides used against Apple Scab, Brown Rot of apples and plums and Leaf Spot of black currants. Among the dithiocarbamates, which have been reported as successful protective fungicides in the United States, he found ferric dimethyldithiocarbamate (the active component of Fermate) unsuitable for use on apple because of its disfiguring and persistent spray residue. Tetramethylthiuram disul-

phide, another material recommended in the United States, proved inferior to lime-sulphur for the control of Apple Scab, though effective in protecting black currants from Leaf Spot. This compound also proved disappointing in trials at East Malling (Montgomery, Moore and Shaw, *Rep. E. Malling Res. Sta.* for 1942, p. 26), and Marsh points out that in the United States the fungicide is added to the long series of arsenical sprays applied throughout the summer against codling moth. With these repeated applications, a mild fungicide might serve to protect the fruit from Scab, whereas here, with only two post-blossom applications, a stronger fungicide would be necessary.

He found that phenyl mercury chloride was equal to lime-sulphur in protection against Scab but that it caused, in certain experimental combinations, severe defoliation and loss of crop. Nevertheless, he pointed out that it has been widely used in the British Isles in combination with lead arsenate, and has proved generally non-phytotoxic. Promising results were given by phenyl mercury chloride used as a winter wash to prevent the sporulation of *Monilia fructigena* on mummified plums.

The most promising Scab fungicide examined by Marsh was 2-heptadecyl imidazoline, one of a number of glyoxalidine derivatives found fungicidal by Wellman and McCallan (*Contr. Boyce Thompson Inst.*, 14 (1946), 151) and protected for use as fungicides by B.P. 598,927. In 1947 heptadecyl-glyoxalidine equalled lime-sulphur, though the weather that year was not favourable to Scab; in 1948, a real Scab year, Marsh found it equal and possibly superior to lime-sulphur (*J. Pomol.*, in the press). Moreover, no evidence of spray injury, even on sulphur-shy varieties, was obtained. The glyoxalidine also gave a satisfactory control of black currant Leaf Spot. Unfortunately, unlike lime-sulphur, glyoxalidine has no acaricidal action, and no information is yet available on its fungicidal action when applied with an acaricide, such as highly-refined petroleum oil, for the control of fruit tree red spider mite.

Another group of fungicides containing neither sulphur nor copper are the chloronitrobenzenes. This group was first examined for fungicidal properties by I. G. Farbenindustrie, and pentachloronitrobenzene was the active component of a product which they marketed for the control of Club Root in cruciferous plants. Brown (*J. Pomol.*, 12 (1935), 247) found this product effective against *Botrytis* on lettuce, for which purpose it was marketed under the name Folosan. During the war the active component of this material was changed to tetrachloronitrobenzene and the name modified to Folosan DB 905. This compound, which is more volatile than the pentachloronitrobenzene, was found to be highly effective for the control of Dry Rot of potato (*Fusarium caeruleum*), for which purpose it was used in Fusarex. Brown (*Ann. appl. Biol.* 34 (1947), 422) observed that, in clamped potatoes treated with either of the chloronitrobenzenes, there was a marked reduction in sprouting. As the tubers are not tainted by the treatment and, from evidence recently published by the manufacturers (*Fusarex Technical Memorandum No. 3*), the risk of poisoning is remote, these compounds should be most useful in reducing potato losses in clamp. An interesting point is that apparently the growth-regulating properties

of these compounds were not known to I.G. who, after a prolonged search, had introduced methyl-alpha-naphthyl methyl ether for the suppression of sprouting in stored potatoes (Luckwill, *Long Ashton Ann. Rep.* (1947), 137).

H.M.

SOILS

Availability of Nitrogen in Composts prepared from Waste Materials. Bould, C. *J. exp. Agric.*, 16 (1948), 103-10.

Methods of estimating the availability of nitrogen in organic manures are described, together with tabulated analyses of some refuse and straw composts. While results from the various methods were not always in agreement, they all showed that nitrogen in mature composts was not readily available. This finding was confirmed by field experiments, where increased yields from crops were obtained when inorganic nitrogen was applied in addition to composts or other organic manures. Further, it was shown that sewage sludge and meat and bone meal were considerably richer in available nitrogen than farmyard manure or composts.

In the preparation of refuse sludge composts as at present recommended, the high temperature developed, while it produces a material tolerably pleasant to handle, causes losses of 10-40 per cent in both the organic carbon and total nitrogen. By treating refuse with liquid sewage sludge during aeration, rapid ammonification takes place and about 30 per cent of the total nitrogen is converted into ammonia after 14 days. If aerobic conditions persist heavy losses of ammonia occur. When such ammonification is completed the residual secondary nitrogen compounds or modified primary ones appear to be very resistant to biological attack. Consequently, little more than the water-soluble nitrogen becomes available as plant nutrient during the first growing season.

Field experiments showed that the best responses to organic material were obtained when it was applied as such and composted in the soil by applications of inorganic nitrogen. This confirmed a Rothamsted experiment where straw and ammonium sulphate added separately to potatoes gave higher yields than an equivalent weight of previously composted straw. Further it was shown that, so far as nitrogen is concerned, composts as a fertilizer are inferior to equivalent amounts of inorganic nitrogen.

Magnesium in Fertilizers, Soil Amendments and Manures. Mehring, A. L. *Soil Sci.*, 66 (1948), 147-57.

With the passage of time important changes have occurred in the sources of magnesium as a plant food for growing crops. About 1900, a tendency to use fish scrap and tankage as feedingstuffs rather than fertilizers developed and towards 1915 became more pronounced. These organic materials contain 0.5-1.2 per cent MgO. Kainite

ABSTRACTS : MACHINERY

(almost 20 per cent MgO), which up to 1915 supplied the bulk of potash in fertilizers, has entirely disappeared. As a result of these changes, the average MgO content of fertilizers fell from 1.39 per cent in 1910 to 0.90 per cent in 1920 and to 0.72 per cent in 1930.

Symptoms of magnesium deficiency in plants became more widespread after 1915, but were not successfully diagnosed until about 1925-30. Consequently, in the United States, the use of dolomitic limestone as a filler and as an anti-acid in fertilizers was developed. Dolomite, unlike high calcic limestones, does not cause losses of ammonia or reversion of the available P_2O_5 under normal conditions.

Apart from using various alkaline salts of magnesia, Epsom salts, either alone or incorporated in fertilizers, has become an important source of the plant nutrient MgO. However, dolomite and magnesia have the advantage over Epsom salts and other sources of magnesium of being much cheaper besides reducing soil acidity. Moreover, in acid soils, the availability of the MgO is much the same from all sources.

For centuries lime has been used as a soil amendment, but prior to 1900 it was believed that it must be caustic, and that any lime containing over 10 per cent MgO was poor, while one with more than 25 per cent was useless. Experiments in 1900 showed that when applied as a soil amendment ground limestone was as effective as either burnt or hydrated lime and that magnesian lime, which was then regarded as toxic both to soil and plant, was superior to either in crop response. Increased use of magnesian limestone, however, was not made until about 1920. From that time its use has increased progressively so that by 1946 the amount used was twenty times that used in 1920.

Until recent years animal manure was the chief source of MgO supply for crops. This material, while still being used at the same level, has now been eclipsed by dolomitic limestone.

In conclusion, the authors state that less than 6 per cent of the total MgO added to soil is derived from fertilizers, and that for maintaining a supply of Ca and Mg in the soil it is better and more economical to apply ground dolomite. Where acidity is not a factor, Mg should be added to the mixed fertilizer either as dolomite or as a water-soluble magnesium salt.

J.W.B.
W.M.D.

MACHINERY

Combine Harvesting, Grain Drying and Storage

Approximately 6,000 combine harvesters were in use last harvest on British farms, and although the majority of these are to be found in the drier areas of the eastern and southern counties, this method of harvesting is also being used to advantage in wetter regions. C. B. Chartres, who farms in Northumberland, quotes figures ("The Harvesting of Grain by Combine and Binder," *Proc. Inst. Brit. Agric. Engrs.*, 3, 7, p. III) to show that whereas his labour requirements and costs for binder work are considerably higher than those in the Eastern Province ("Harvesting by Binder and Combine," *Fmrs' Bull. (Camb.) No. 9*), his labour requirements and costs for combines are not particularly high,

indicating that the advantage of combining over the binder method is no less pronounced in Northumberland than in the drier parts of the country. This is in accord with the claim made by several users of combine harvesters, particularly where farms are equipped with grain driers, that it is in a season of bad harvesting weather that they secure the greatest advantage by using the combine.

McIver (*Bull. No. 16, Edinb. Coll. Agric.*, Combine Harvesters in E. and S.E. Scotland, 1947) in giving an up-to-date account of combine harvesting in Scotland, confirms this conclusion and finds the cost of combine harvesting in an extremely bad season (1946) only slightly higher than in a good season. This bulletin provides details of the performance of various types of combine harvester, the crops harvested by combine, costs of combine harvesting, grain drying and storage facilities available, and methods of straw disposal.

The rapid increase in numbers of combines has not been accompanied by a corresponding increase in grain drier capacity. While the number of conventional type grain driers steadily increases, considering the country as a whole, there are a few farmers in specially favourable areas who have been so bold as to get rid of driers that were technically satisfactory—on the grounds of redundancy. There is little sound factual evidence on the moisture content of combine harvested grain, but a survey by the N.I.A.E. of the grain harvested by combines on four farms in Bedfordshire in 1948 provides useful data. Cashmore ("Combine Harvester Design," *Agric. Eng. Record*. Winter, 1948-9) observes that in this harvest, which was neither much better nor worse than usual, most of the grain was harvested at a moisture content of between 16 and 22 per cent.

It has now been demonstrated conclusively that in the drier parts of the country it is a practical proposition to use the combine harvesters only when the corn is reasonably dry, and to dry the grain slowly in bulk, in specially constructed or specially adapted bins. As in an ordinary drier, an air-stream is used to convey heat to the grain and to carry away water. A large volume of air, only slightly warmed, is blown through a false bottom or through special ducts in the bin, and it gradually dries the grain from the bottom upwards. The N.I.A.E. has prepared a comprehensive bulletin on the whole subject of drying grain in bins (*A Farm Plant for the Combined Drying and Storage of Grain in Bins Ventilated with Conditioned Air*), and this includes such important practical details as a satisfactory form of construction, rate of air flow required, recommendations as to the amount of heating of the air, and methods of controlling air temperature and humidity. The bulletin also gives the results of a complete season's work with a plant consisting of six ventilated bins 10 ft. high and 13 ft. in diameter. All the grain on the farm, a total of 166 tons including wheat, oats and barley, was combined using a 5 ft. cut machine. Moisture contents ranged from 15 per cent to 24.5 per cent (the latter a very little which needed careful treatment). 25 tons of wheat and 13 tons of oats needed no drying. This bulletin merits careful study by all N.A.A.S. officers concerned in any way with the harvesting of corn by combine.

The scientific principles underlying grain drying and storage are ably explained by T. A. Oxley, *The Scientific Principles of Grain Storage*. Northern Publishing Co., Ltd., Liverpool, 1948. It will probably surprise many readers to learn that the heating of damp grain is caused partly by microscopic fungi which are situated *beneath* the epidermis of the grain, that the physical properties of grain in bulk are such that undisturbed wheat in the middle of a large silo may be hottest in mid-winter and coldest in midsummer, that attempts to "air" grain in a store by leaving doors and windows open are almost invariably useless so far as the grain is concerned, though possibly it may help the building, and that it is highly improbable that leaving open the necks of sacks containing warm or damp grain has any effect at all, the important point being to stack the sacks singly with air spaces between. Scientific reasons are given for such phenomena as the sweating of grain when sacks are placed on a cold floor, and many useful data are provided.

An article by T. A. Oxley ("New Ideas in Grain Storage," *British Agricultural Bulletin*, 1 (1948), 28) outlines systems of bin ventilation and discusses other new ideas that are probably of less practical consequence.

It is interesting to note that the little grain drying that is carried out on farms in the United States is done mainly in home-made bins. A recent article ("A Wet Season Boosts Need for Crop Dryers," *Implement and Tractor*, 21.8.48., 37) briefly describes nine driers that are marketed in America. These almost invariably consist merely of an oil burner with a combustion tunnel, a mixing chamber and a fan. The farmer provides the simple structures which hold the crops to be dried—mostly maize on the cob. In general, these units are small, requiring power units of only 3-5 h.p.

A paper by C. B. Chartres ("Grain Drying and the Combine Harvester," *Fuel and the Future*, 1 (1948), 332, H.M.S.O.) gives figures on the fuel used for grain drying, and emphasizes the practical advantages of thermostatically controlled oil-fired furnaces for conventional grain driers.

C.C.

PROVINCIAL NOTES

WINTER BEANS IN SOMERSET, 1940-47

THE CHOCOLATE SPOT DISEASE PROBLEM*

G. E. FURSE

Crop Husbandry Advisory Officer, South-Western Province

Observations, experimental work and general cropping records with the field winter bean crop in Somerset in general and at the Somerset Farm Institute, Cannington, in particular.

There is no doubt at all as to the serious effect of Chocolate Spot disease and/or other leaf diseases on the yields of field beans in the S.W. in the years under review. Because of the considerable risk of recurrence in any future year, the acreage under this crop in the S.W. has been drastically reduced (see Table). The farmers are very reluctant to grow straight bean crops owing to this risk, and the Advisory Officers cannot recommend the growing of this all-important protein crop with any degree of confidence. More interest is developing in the growing of winter and spring mixed corn mixtures with legumes, and the N.A.A.S. S.W. Province Crop Husbandry Department is following up this line by means of a number of experimental or exploratory plots.

We appear largely to have lost the art of bean growing in the S.W. and our work in trying to find means to recover this art, whether with beans alone or in mixtures, is of very great importance in our efforts to be self-supporting in home food production.

GENERAL NOTES ON BEAN GROWING ON THE CANNINGTON INSTITUTE FARM

1. Usually the soil is described as a silty loam on red marl formation, i.e., not the best bean land. The farm is in a general high state of fertility.
2. Soil analysis of all the fields on the farm in November, 1945, showed a general low availability of potash—from 0.003 to 0.008 per cent—and available phosphate from 0.014 to 0.060 per cent. Hence the potash status may be estimated as generally low; the phosphates status, in many cases, is high.
3. Weather records from the Ministry of Agriculture's Crop Weather Station on the Institute farm are available from 1928 onwards. The altitude of the farm is between 10 and 100 ft. above sea level.
4. Black Aphis did not appear on beans to any noticeable extent in any of the years 1940-47 at Cannington, even though this pest was very severe on the farm beet and mangold crop in May and early June, 1944. Generally it was very severe, on beet in particular, in Somerset in 1944.

*This article presents in a curtailed form a report prepared primarily for the Agricultural Improvement Council. A copy of the full report is available on request.

WINTER BEANS IN SOMERSET, 1940-47

NORMAL FARM CROPS OF BEANS AT CANNINGTON 1940-47, AND SOMERSET BEAN CROPS IN GENERAL IN THESE YEARS

Full details of previous cropping, manuring, date of sowing, seed rate, cultivations, diseases, yields, etc. are given year by year in the full report. A summary of disease incidence and yield is set out below:

- 1940. Little disease. Threshed yield 20 cwt. per acre. County crops satisfactory and little record of disease.
- 1941. Very little disease. Threshed yield 24 cwt. per acre. First reports of Chocolate Spot troubles coming in from the county.
- 1942. Disease fairly severe. Threshed yield higher than anticipated—16 cwt. per acre. Considerable disease effects in the county.
- 1943. Disease fairly severe at Cannington in conjunction with severe potash deficiency. Threshed yield 9 cwt. per acre. Disease fairly severe throughout the county.
- 1944. Disease severe at Cannington and in the county generally, appearing unusually early (mid-April). Threshed yield 8 cwt. per acre.
- 1945. Disease appeared in early June at Cannington and developed to fairly severe attack by July. Threshed yield 8 cwt. per acre. Disease very severe throughout the county.
- 1946. Severe disease effects at Cannington, combined with severe potash deficiency symptoms. Threshed yield was nil (crop burnt). Disease severe all over county—most severe of all the years.
- 1947. Disease observed mid-May but did not develop very much in this dry year. Threshed yield 20 cwt. per acre. The few crops in the county yielded quite well.

SUMMARY OF CHOCOLATE SPOT INCIDENCE IN SOMERSET IN THE YEARS 1940-47

- 1940. None observed (probably not the close watch for the disease in this early year compared with later years).
- 1941. } Slight.
- 1947. }
- 1942. } Fairly severe.
- 1943. }
- 1945. }
- 1944. Severe and unusually early appearance (early April).
- 1946. Probably the worst year of all.

SOMERSET BEAN ACREAGES (JUNE 4TH RETURNS)						
1939	...	...	2,161 acres	1943	...	8,176 acres
1940	...	...	1,355 acres	1944	...	7,971 acres
1941	...	...	4,278 acres	1945	...	3,965 acres
1942	...	...	6,706 acres	1946	...	3,263 acres
				1947	...	1,476 acres

These figures reflect the increase in acreage in the early years of the war built up by propaganda, etc., followed by a severe reduction after the 1944 Chocolate Spot troubles and a further severe drop after the very severe disease damage in 1946.

This effect on the acreage was not confined only to Somerset in the S.W. The total acreage figures for the six N.A.A.S. S.W. Province counties (Cornwall, Devon, Somerset, Wiltshire, Dorset and Gloucester) were :

1944	...	...	...	...	...	25,030 acres
1947	...	...	...	...	...	4,723 acres

This shows that Somerset's 1947 acreage was 18 per cent of 1944 acreage, and the S.W. Province as a whole showed 1947 as 19 per cent of 1944. It may be argued that this reduction was not due entirely to Chocolate Spot, or other leaf disease troubles, but in the writer's opinion the disease was almost entirely the cause.

EXPERIMENTAL PLOTS AT CANNINGTON AND OTHER SOMERSET FARMS IN 1944 AND SUBSEQUENT YEARS

These were purely observational experimental plots and no attempts were made to get yields from them.

In many cases the points under observation were repeated at a number of the Somerset A.E.C. so-called demonstration farms, i.e., ordinary farms used to demonstrate certain important features of crop and grass-land husbandry (by permission of the farmers concerned). These farms were situated in each of the eight A.E.C. districts.

Factors included :

1. Various row spacings (11 in., 22 in., and 33 in.).
2. Old seed and new seed.
3. Various fertilizer treatments with potash as the main theme.
4. Seed dressed Agrosan G. and non-dressed.
5. Ploughing-in and drilling-in.
6. Spraying with Potato Blight sprays to prevent and control the disease.

Summary of Observations :

1. It was believed that somewhere between 22 and 33 in. might be the optimum row spacing.
2. No difference between old seed (year old) and new seed (from previous crop) was discernible.
3. The value of potash was clearly emphasized, especially for a field recently ploughed out of old grass that has been mown for hay for many years. Potash and phosphate together gave rather better results than potash alone.
4. There was no apparent difference between the plots of dressed and non-dressed seed.
5. For some unknown reason the drilled beans failed in 1944, whereas the ploughed-in crop was satisfactory.
6. Results rather negative ; in most years spraying is not possible in a thick tall crop. (This work was carried out in conjunction with the Advisory Mycologists at the Long Ashton Research Station.)

POTATO ROOT EELWORM IN THE NORTHERN PROVINCE

Conclusions from all work carried out

1. Potash is extremely important in bean growing, particularly on non-bean lands, i.e., the non-heavy soils.
2. F.Y.M. may be of greater value for beans than some have given it credit for. Pre-war in Somerset the common manurial practice for beans was phosphate only, though some farmers always gave a light dressing of F.Y.M. and enquiry revealed that these farmers often get more consistently good crops.
3. Bean crops in the S.W. often reach maturity as too thick a "plant," i.e., too crowded. Farmers in general contend that a thinner crop "pods up" better and therefore :
 - (a) A seeding of $2-2\frac{1}{2}$ bushels would probably be better in the S.W. than $3-3\frac{1}{2}$ bushels per acre. Winter killing is less in the S.W. than the E., where heavier seedings are favoured.
 - (b) Wider spacing than the normal 18-22 in. may be a help in better podding and in better Chocolate Spot control—26-28 in. is suggested.
4. Mixed corn crops with beans included need further exploration now that straight bean crops are such a gamble.
5. The plant breeders may help with disease resistant varieties.
6. Spring beans (Tick, Spring and Mazagan) were tried in several of the years under review, but were not more consistently successful than winter beans. The reason for poor results from spring beans is not very clear—for reasons other than Chocolate Spot they often fail to finish off satisfactorily, i.e., poor "podding up".

Finally it is emphasized that although up to 1941 Chocolate Spot did not cause appreciable trouble more than one year in seven or eight in the S.W., from 1942 onwards the damage has been extremely severe. It has largely been the cause of the serious reduction in the bean acreage in the S.W. counties. What has been the cause of this? Is it some new forms of leaf diseases other than Chocolate Spot?

Note. The above work was carried out under the control and supervision of W. D. Hay (Chief Advisory Officer to Somerset A.E.C., Principal of the Cannington Farm Institute and County Agricultural Organizer).

POTATO ROOT EELWORM IN THE NORTHERN PROVINCE

M. COHEN

Provincial Entomologist, Northern Province

Prior to the setting up of the N.A.A.S., it was known that potato root eelworm occurred in the Northern Province on allotments and gardens, but there was no record of its occurrence on farms. Systematic survey work in 1947, however, revealed the existence of a well-defined eelworm-infested area in Durham and isolated infested fields in Northumberland and Cumberland. The information so obtained indicated that with one exception the infestations were not of recent origin.

The Position in County Durham

Durham possesses the most important potato-growing district in the Northern Province. The light soils of the coastal strip between Sunderland and Seaham Harbour are particularly easy to work, and the cultivation of potatoes has been practised intensively for a long period. The proximity of good markets has also contributed to the popularity of the crop, so that potatoes occur closely in the rotations. It is in such a district, where intensive cropping occurs, that potato root eelworm is likely to appear.

The Sunderland-Seaham coastal strip constitutes the main eelworm area in Durham, and indeed in the whole province. The area is roughly triangular in shape, the base being the three miles of coast with Ryhope as the centre point and the apex extending to a point four miles inland just west of Herrington—roughly six square miles.

To date, 89 fields (725 acres) have been sampled in this area. Of these, 59 or 66 per cent proved to be infested, representing 58 per cent of the acreage sampled. Sixty-five per cent of the eelworm counts fell in the group 0.1-2.7 "full" viable cysts per 10 grm. soil, and the highest count, which was 4.6 "full" viable cysts per 10 grm. soil, was recorded only once. Isolated infested fields have also been found in the extreme south of the county on old-established market gardens. In the north of England a count of four "full" viable cysts per 10 grm. soil is considered to be the top level of infestation at which an average crop may be obtained, and on this score the Durham infestations are quite low. Nevertheless, even these low infestations may cause appreciable crop reduction under a combination of climatic and cultural factors; amongst these the growing of potatoes in alternate years is the most likely to increase loss and the degree of infestation.

In Northumberland six cases of field infestation have been recorded in the south of the county, and the eelworm has been noted in two fields only in Cumberland, and not at all in Westmorland.

Prevention of Increase and Spread of the Pest

Advisory Leaflet No. 284 gives details of the life history of the eelworm, with notes on control measures, but there are some points worth emphasizing.

Good markets and intensive cropping tend to make farmers less conscious of the very great value of rotations, and cross-cropping occurs all too frequently. Further, in areas such as that in Durham, fields are often differentially cropped and the subdivisions of such fields are not marked by permanent fences. This makes it difficult to define accurately the boundaries of any one crop the year after it has been taken, and unintentional partial cross-cropping may result from the overlapping of crops in successive years.

Cross-cropping, intentional or otherwise, should be avoided where eelworm is present.

Potato fields should be harrowed thoroughly after harvest so as to reduce the number of groundkeeper or volunteer plants in the next two or three crops, because such plants act as reservoirs of infestation and tend to reduce the benefits from resting the land. Clamp sites are often

more heavily infested than the remainder of the field and, if taken into cultivation, may provide a nucleus of heavy infestation in later potato crops.

Brassica plants raised in infested fields can spread the eelworm to clean fields, because cysts may be carried in the soil attached to the roots of such plants. Similarly, infestation may be spread by small quantities of soil carried on implements, and the latter should be cleaned thoroughly after working infested fields and before proceeding to "clean" fields.

Probably, in the Northern Province, it is safe to take potatoes once in four years on this lightly infested land if adequate quantities of farmyard manure and artificials are used. The longer the land can be rested, the better the chances for future crops of potatoes.

Experience in the Northern Province, as in other provinces where the pest occurs, has demonstrated the great value of systematic sampling of farms. In this way a farmer can be given a map of his farm showing which fields are infested, which should be rested from potatoes, and which can be cropped with a reasonable prospect of an average yield. Such advice will help to limit the spread and build-up of a pest, which, unlike the Colorado beetle, is already established in the country and is, without doubt, seriously affecting both the yield and cost of production of the potato crop.

COMMONWEALTH AGRICULTURAL BUREAUX PUBLICATIONS

In addition to the periodical and abstracting journals published by all Institutes and Bureaux in this organization, there appear from time to time various types of occasional publications containing reviews or bibliographies on questions of current importance in the agriculture of this country or other parts of the British Commonwealth. The following may be of interest to advisory and research staffs in Great Britain.

Phenothiazine 1942-46 : A Review and Bibliography. (Nov., 1947, 4s.)

A continuation by Edwards of the review by Davey and Innes (1942), together with a bibliography by the Commonwealth Bureau of Agricultural Parasitology in continuation of that published in 1942.

Pregnancy Diagnosis Tests : A Review. (Sept., 1948, 15s.)

The author has surveyed all important papers on the diagnosis of pregnancy in women and domestic animals, with the exception of those concerned with clinical methods in women. The opening chapter deals with clinical methods applied to domestic animals. The other tests are classified according to their basis on hormonal, enzymic, other biochemical, immunological and physiological phenomena. Their accuracy under different conditions and for different species is assessed. This review will thus be of direct interest to research workers in the fields of animal and human reproduction as well as to practising veterinarians, gynaecologists and obstetricians. The text runs to 180 pages and the bibliography includes nearly 2,000 references.

Diet in Relation to Reproduction and the Viability of the Young.

Part 1. Rats and other Laboratory Animals. (Dec., 1948, 6s.)

The effects of dietary deficiencies on the reproductive performance of laboratory animals are briefly described and data are reviewed which relate to the quantitative requirements for proximate principles, minerals and vitamins during the processes of reproduction and rearing of the young. An attempt has been made to correlate the results of such studies with the reproductive success obtained with stock diets, subject to the limitations imposed by the operation of non-dietary variables which influence reproductive performance.

Records of the "normal" reproductive performance of farm animals (excluding poultry) will be presented in Part II of this series. The value of dietary experiments in reproduction will be discussed against that background and dietary requirements, as far as possible, defined. Part III of this series will deal with poultry and will include the effects of diet on egg production, on the hatchability of the eggs and on the viability of the chicks.

Orders for all three parts in this series can now be accepted and invoices for later parts will be issued when these parts are published.

Growth Substances and their Practical Importance in Horticulture. (Dec., 1948, 12s. 6d.)

An up-to-date review which brings together the widely scattered data relating to the actual and potential uses of synthetic growth substances in horticulture and the technical problems involved in their use. The following aspects of the subject, amongst others, are covered: the stimulation of root development in cuttings, hormone treatment of seed and seedlings, the treatment of growing plants, induced parthenocarpy selective herbicides, the inhibition of bud development, the control of flowering, and the prevention of abscission.

Five Hundred Varieties of Herbage and Fodder Plants. (1948, 15s.)

This work brings together, firstly, information received from specialists in many parts of the world on crop varieties used in the feeding of farm stock. The notes have been made to give, in as concise a form as possible, the necessary details regarding origin, adaptation, characteristics, and use of the strains in various countries, together with possibilities of obtaining supplies. Secondly, the index has been designed to supplement the first part, and contains references to published information on crop varieties compiled over a period of 17 years in the Commonwealth Bureau at Aberystwyth.

The information which is collated in this way for the first time will reveal not only the need for a completion of the data by the inclusion of entries from other countries, but also the desirability of some attempt by research workers to achieve uniformity in standards, nomenclature, synonyms, etc.

